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Manual for army bakers

United States. War Dept. Subsistence Dept

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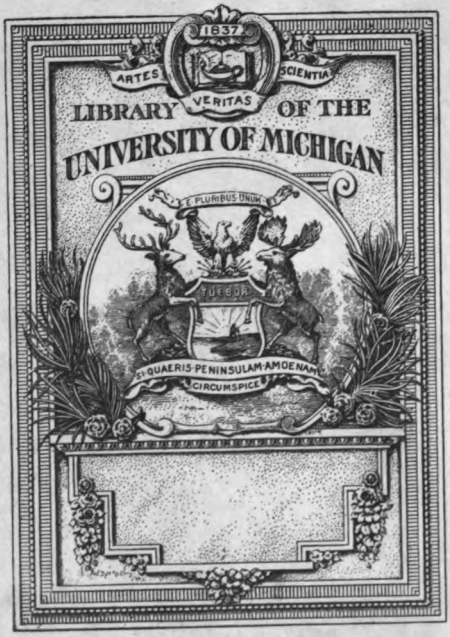

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MANUAL FOR
ARMY BAKERS

1910

U. S. Subsistence

WASHINGTON
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1910

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WAR DEPARTMENT

Document No. 358

OFFICE OF THE COMMISSARY GENERAL.

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WAR DEPARTMENT,
OFFICE OF THE CHIEF OF STAFF,
Washington, December 15, 1909.

The following "Manual for Army Bakers," prepared under the direction of the Commissary-General, U. S. Army, by a board of officers consisting of Capt. Henry T. Ferguson, Commissary, Capt. Francis J. Koester, Commissary, and Capt. Lucius R. Holbrook, Commissary, is approved and herewith issued for the information and guidance of the Regular Army and the Organized Militia of the United States.

By order of the Secretary of War:

J. FRANKLIN BELL,
Major-General, Chief of Staff.

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MANUAL FOR ARMY BAKERS.

CHAPTER I.

WHEAT AND FLOUR.

1. **Flour** is a general term used to designate the finely ground meal of wheat, rye, or other cereals, but in this manual it will be used specially to designate wheat flour unless otherwise stated.

2. Wheat flour is ground from—

(*a*) **Winter wheat**, which is sown in the fall and is hardy enough to survive the winter; or from,

(*b*) **Spring wheat**, which is sown in the spring.

CLASSIFICATION OF WHEAT.

3. **Winter wheat** is generally classed as *soft wheat* and **spring wheat** as *hard wheat*, but there are hard and soft varieties of both. Generally speaking, flour from hard wheat contains a relatively large proportion of *gluten*, say from 10 per cent to 16 per cent, and flour from soft wheat much less, generally from 7 per cent to 9 per cent. From a baker's standpoint, *starch* is of secondary importance. Flour is composed almost entirely of these two elements and each serves a most important function in the process of bread making.

Winter wheat is divided into two general varieties, *red winter wheat*, which is hard, and *white winter wheat*, which is soft. It is raised in climates where the weather is not excessively cold, e. g., Ohio, Indiana, Missouri, Kansas, Oklahoma, and the Pacific coast. Missouri, Kansas, and Oklahoma produce specially fine hard winter wheat. The grains of the Pacific coast winter wheat are large and well formed, but contain a relatively large proportion of starch and little gluten.

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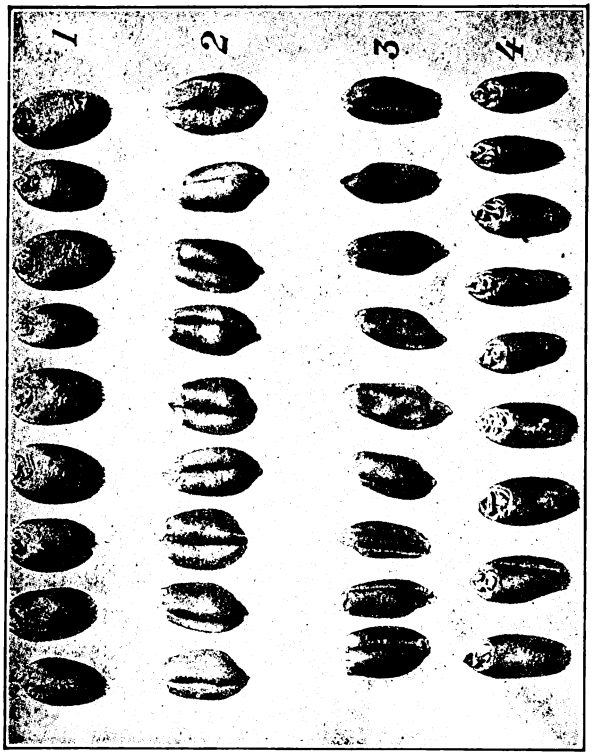

U. S. Dept. of Agr., Bul. 156, Office of Expt. Stations.

1 and 2 are samples of Oregon White Winter Wheat.
3 and 4 are samples of Oklahoma Winter Wheat.

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Spring wheat is generally classed as a *hard wheat*, and its value rated according to its strength (par. 7). It may be raised in the more severe climates, and we find most excellent spring wheat flour of a hard variety coming from Minnesota and the Dakotas, the newer the territory, the harder is the variety of wheat produced.

SWEATING OF WHEAT AND FLOUR.

4. About September or October the wheat from the new crop and the flour made from it undergo a natural change of condition. They evolve (or give off) a portion of the water contained in them, and this change is accompanied by a rise in temperature. After passing through the sweat the wheat becomes dry, hard, and flinty, and it should not be milled until this time. Flour takes on a darker appearance during this period, and if it does not sour it becomes white again as the sweat passes off. While passing through the sweat it should not be used. If made from wheat that has not yet passed through the sweat it should be used up as soon as practicable in order that it may not become musty and a total loss. Wheat is generally allowed to sweat in the stack, and always before milling, unless it is intended to use the flour at once.

MILLING.

5. There are two processes of milling which are known as—

(*a*) *Low milling*, in which the grain is ground between two large round flat stones with radial grooves cut in their grinding faces. One revolves at such a distance from the other, which is stationary, as to crush the grains and finally reduce them to powder. In this process the flour is heated to a temperature of at least 120° F., and it is believed that this injures the gluten, making it less tenacious and consequently less fit for making light bread. In addition there is the objection that portions of the indigestible husks are ground into meal and mixed with the flour.

(*b*) *High milling*, in which the grains of wheat are passed successively between several sets of rollers, crushing the flour out of the husks, which are easily removed. The screened wheat is first moistened and passed between the corrugated surfaces of two rollers placed at such a distance apart as to simply crack the grains. The

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STRUCTURE OF THE WHEAT KERNEL.

A, Germ; B, Starch cells; C, Gluton cells; D, Inner coat of bran; E, Testa (coloring matter of bran); F, G, H, Three outer coats of bran.

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moisture prevents the outer husks from breaking up into small particles and renders the separation of the bran a comparatively easy matter. The rollers of the next set are placed much closer together, and after the grains have passed through, a small quantity of flour, called "break flour," together with larger particles of wheat, called "middlings," is separated by means of screens and bolting cloths. The remainder, called "tailings," is passed through the next set of rollers. After each of several such "reductions" the flour and middlings are separated and the latter passed between closely set *smooth rollers*. The bran, shorts, and other offals are removed at the different boltings from the several breaks.

In both processes the flour is bolted through successive sieves of different fineness, the last being white silk of the finest bolting cloth. The finest grade of flour passes through the last sieve, and the coarser grades are left on the way, while the bran husk is entirely separated. High patent and family flours have more or less of the gluten removed in the successive bolting processes through which they pass and are consequently slightly less nourishing.

COMPOSITION OF WHEAT.

6. **Hard wheat** ordinarily contains about—

10 per cent water.

12 per cent gluten (the inner coat and distributed throughout the grain, producing flesh and muscle).

The amount and quality determine the water-retaining capacity of a flour and regulate the quantity of bread produced. (See pars. 8 and 9.)

13 per cent bran (the five outer coats), strong in woody fiber, mineral ingredients, and coloring matter. It is very indigestible and is mostly excluded from the flour in the process of manufacture, except where graham is desired.

65 per cent starch, producing heat and fat. It is the water absorber. During the process of fermentation a small proportion—about 2 per cent—is transformed into alcohol and carbonic gas. The carbonic-acid gas forms in cells, giving lightness to the bread, but the alcohol is vaporized in the oven, where most of it escapes.

The proportions in which the several ingredients appear vary considerably in different flours. For example, Oregon white winter wheat contains about 9 per cent gluten, Minnesota hard spring wheat

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about 14 per cent, and Oklahoma hard winter wheat about 16 per cent. All wheat raised in low damp countries contains more moisture and generally less gluten than that raised in higher and drier climates.

Soft wheat contains less gluten and more starch and water than hard wheat.

STRENGTH OF FLOUR.

7. THE STRENGTH OF A FLOUR depends upon the amount and quality of the *gluten* it contains. The great elasticity and tenacious character of gluten render the making of light bread possible. It forms layers of envelopes within the dough, preventing the escape of the *carbonic gas* resulting from *fermentation*. This gas, as it rises, forms in pockets or cells, causing the dough to expand, and gives corresponding lightness to the bread.

GLUTEN IN BREAD.

8. The best bread is made from a flour containing from 10 per cent to 16 per cent of gluten, *but the quality of the gluten has as much to do with the bread as the quantity*. The gluten in wheat raised in low damp countries contains much moisture, and therefore appears to be in greater quantity than it really is. It is not tough enough to retain the fermentative gases, and consequently the bread is heavy and of poor quality. Gluten of poor quality is also found in the flour of sprouted wheat, of wheat that has been frosted, and of that which is immature or that has been raised on worked-out soil.

SEPARATING THE GLUTEN.

9. In order to determine the percentage of *gluten* contained in a certain lot of flour, weigh out a definite amount, say 1 to 3 pounds, very carefully. Add sufficient water to make into a stiff dough. Let stand for about an hour (if convenient, though this is not absolutely necessary). Place in a bag of muslin and knead gently under a quiet stream of running water. The starch gradually separates, making the water "milky." When it runs clear, the starch has all disappeared.

The substance remaining is known as "wet gluten." In this state it contains approximately three parts water and one part gluten,

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so that the amount of "dry gluten" can be ascertained approximately by dividing by four; but it would be better to set it on the top of the oven and determine its weight accurately after it has dried out for forty-eight hours. If 1 pound of flour were taken, the amount of "wet gluten" obtained might run as high as 7 or 8 ounces, and this would be reduced to, say, about 2 ounces after thoroughly dried out. The percentage of gluten present in the flour is found by dividing the weight of the dried gluten in ounces by the number of ounces of flour used in the test.

The actual amount of gluten found is of importance, in that it represents the percentage of muscle-building material present in the flour. The strength of the flour is determined more by the *quality of the gluten* found than by the amount. If strong, the gluten will be solid and tough; but if from a weak flour it will be more plastic. It would be well to make the test with flours that are known to be strong and others known to be weak, in order to get a standard in the mind for comparison.

As a matter of fact gluten as such does not exist in wheat or dry flour. Two elements of flour, known respectively as *glutenen* (a light grayish substance) and *gliadin* (resembling glue) quickly unite in the presence of water and form the so-called gluten.

FLOUR USED IN BREAD MAKING.

10. **White bread** (or light bread) is made principally from white flour, which is also an important ingredient in most other breads. Bread, if made of *rye flour* alone, would be heavy, moist, sticky, and indigestible. *Corn meal* alone would make a dry and crumbly loaf. Excellent bread results when there is a mixture of wheat flour with either of the other kinds mentioned. (See par. 72.)

11. **Graham flour** is a mixture of bran and shorts generally with a more or less inferior grade of flour, and although it was formerly considered a valuable article of diet—especially for those suffering from constipation—it is now deemed best to discard bran as unfit for human food; and where the large flakes of bran are found in graham flour it would be best to sift them out. The outer bran husk is almost pure silica (glass), and in passing through the system it scratches the delicate membranes, setting up an irritation, causing increased secretions, and consequently acting as a laxative. For this reason its constant use is not recommended.

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A first-class milling company has given the following formula for the preparation of graham flour:

270 pounds of *second grade flour.*
100 pounds of *shorts.*
30 pounds of *bran.*

Total.....400 pounds.

As shorts and bran are practically indigestible in the human stomach, it is noted from the above formula that the graham thus prepared contains but 67½ per cent as much actual nutriment as a corresponding weight of the white flour used.

12. **Rye** is darker than wheat, but is otherwise similar in appearance. It differs from it in that its gluten has not the same elastic and tenacious quality, and consequently it will not produce as light a loaf. It is more easily cultivated than wheat, especially in cold countries, and consequently costs less when raised in quantity. Wheat is fast replacing rye throughout the world, although the latter grain contains more muscle-making material (though probably it is less completely digested), and it is still the principal food used among the poor of certain countries of the old world. It constitutes the bread component of the ration of the Russian soldier.

WHERE TO STORE FLOUR.

13. Flour ordinarily contains from 9 to 14 per cent of water, and under the influence of heat—natural or artificial—not strong enough to expel the moisture, but strong enough to start fermentation, it will heat and sour. Flour is peculiarly sensitive to the exhalations from other substances, and should not be stored in the same room with sour liquids, decaying vegetables, or articles that emit unsavory or noxious vapors. For the reasons stated it is evident that *flour should be kept in a cool, dry, well-ventilated store-room.* If properly taken care of it will keep in a good condition for a year or more. A temperature of 70° F. or slightly less is best. High temperature favors acid fermentation and mold.

In order to protect flour against *rats* and *mice* newspapers should be loosely stuffed in convenient cracks. They will use these in preparing their nests and leave the sacks alone.

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KEEPING QUALITIES.

14. **Wheat** improves in quality until after it passes through the sweat (par. 4), after which it does not undergo any perceptible change for years.

By some bakers it is claimed that *freshly ground flour* is the best. Generally, it is claimed that it increases in bread-making properties as it gets older up to a certain limit and should not be used until it is at least thirty days old. It reaches a stage in three or four months beyond which time it does not continue to improve, and while it retains its acquired good qualities for a few months it soon begins to deteriorate and should not be kept for more than a year. When animal and vegetable parasites begin to appear it is generally an indication of decomposition of the gluten and consequent deterioration of flour.

15. **Weevils and cockroaches** often work their way into good flour under certain circumstances and should be removed by passing the flour through a sieve. Much of the flour received in the Philippines (after a long ocean voyage in the hold of a ship) is found to be fairly alive with these little insects, and if the flour were destroyed or thrown away the troops would at times be without bread. Inasmuch as such insects have frequently been found in tinned flour presumed to have been hermetically sealed soon after milling, it must be that the germs from which they develop exist in the wheat and survive the process of milling, or that some cans are not air tight, and that the vermin enter at the leaks and deposit their eggs, which is more likely. Bread made from such flour has a distinctly cockroach flavor.

16. **Wet flour.** Flour that has become wet and quickly dried is not spoiled. Sacks of flour left in the rain or dropped into the water should be dried at once in order to prevent molding. If taken care of at once the loss will be small.

TESTS OF FLOUR.

17. **The best test of flour** is said to be in the baking, but there are many indications as to its true quality before we have proceeded to this stage. Good flour should not be of a pure white color, but of a creamy, yellowish-white shade, although color alone is not a guarantee of quality. If pure white, or nearly so, the indications are

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that a large part of the gluten has been removed in milling and what is left is almost pure starch. If flour feels damp or sticky it is not of the best. Good flour falls loosely apart when squeezed in the hand and retains the impression of the fingers and even of the skin much longer than poor flour. If a handful is thrown against the vertical side of the trough, and a considerable portion of it hangs there, the indications are that the flour is rich in gluten; when rubbed between the fingers it should not feel too smooth and powdery, but its individual particles should be vaguely distinguishable; when put between the teeth it should "crunch" a little; its taste should be sweet and nutty without a suspicion of acidity and it should have the smell and taste of freshly ground wheat. Good flour, when kneaded into dough, is elastic and easy to handle. It will stay in a round puffy shape and will have taken up a great deal of water. Poor flour will be sticky, flatten out, and run over the board, and will never seem to get sufficiently stiff, no matter how much flour is added to it.

BLENDING OF FLOUR.

18. **Good bread** can be made from the flour of either winter or spring wheat, but best results are obtained from a mixture of two or more brands of flour, using both spring and winter wheat where practicable. The flour from winter wheat is required for *light color* and *superior flavor* and that from spring wheat for strong gluten. The miller can do the mixing in the process of manufacture and civilian bakers by specially prepared apparatus, but in the hands of the post baker it can be best done by using the best flour in the sponge and the poorer flour—that is, the one containing the least amount of gluten—in kneading the dough. Winter wheat alone is often used in making crackers and pastries, as the resulting product is white and brittle. A flour strong in gluten is desired for making bread.

19. **Sifting.**—All flour, regardless of its presumed condition, should be carefully sifted before used. Nails, pieces of twine, slivers of wood, mouse droppings, etc., in addition to hard lumps, are frequently removed from flour supposed to have been put up in the most careful manner.

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BLEACHED FLOUR.

20. Very good flour, as well as the inferior grades, has frequently been bleached in order to secure a higher price or more ready sale on the market, as *very white bread as well as light bread is frequently in demand.*

Flour may be bleached by careful exposure to the sunlight, but ordinarily bleaching is accomplished by passing nitrous or sulphurous fumes over it. The actual chemical change resulting and the effect upon the system are not yet well understood, but where chemicals are used the Department of Agriculture holds that there is adulteration.

When electrical appliances are used in connection with bleaching of flour, it is *possible* that the actual bleaching is still done by the fumes of nitrous oxide produced by the electric current. The exact cause of the bleaching seems to be unknown, even to the Department of Agriculture. Bleached flour is not usually purchased for army use.

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CHAPTER II.

YEAST.

(A) ELEMENTARY PRINCIPLES OF FERMENTATION IN BREAD MAKING.

21. In order to understand the process and purpose of bread making, it must be remembered that flour consists largely of *starch* and *gluten* and that these ingredients can be taken up and used in the system only after they have been converted into more soluble forms.

Something must also be known about the process of *fermentation* which renders it possible to make bread that can be easily digested by the juices supplied within the body for that purpose.

22. **Fermentation.**—Light bread can be made by forcing compressed air through wet dough and baking at once, or by making use of the gas generated by certain so-called "baking-powders" (see par. 30), but from time immemorial the ordinary process has been to set up fermentation within the dough by some means or other, utilizing the gas generated to produce the cellular structure. "A microscopical examination was recently made of some bread over four thousand and four hundred years old, found in Egypt, with other remains of a long vanished people. It was made of ground barley and the yeast cells were plainly visible."—H. W. Atwater, U. S. Department of Agriculture.

DEPARTMENT OF AGRICULTURE.

Now *fermentation* is simply the change which takes place in vegetable matters when the starch and sugar they contain are decomposed and changed into new compounds. The change is hastened by the presence of a certain amount of *moisture* and a *uniform temperature* of from 80° to 90° F., and may take place in two ways:

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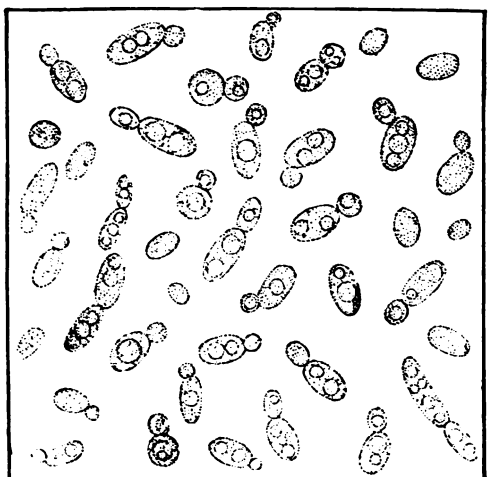
(*a*) It may be spontaneous under favorable conditions of *air*, *moisture*, and *warmth*. Such is the case when *head* (virgin or maiden) *yeast* is made, no ferment being added to the solution to start the fermentation. Grape juice, cider, etc., ferment in the same manner.



Atwater, Bull. 112, U. S. Dept. of Agriculture.

YEAST PLANT.

(Highly magnified.)

Each yeast cell is said to reproduce itself in from four to five hours under favorable conditions. The growth and development of cells as seen under the microscope is illustrated above.

Spores of fermentation are at all times floating about in the air and *fermentation will start up spontaneously wherever proper conditions exist*.

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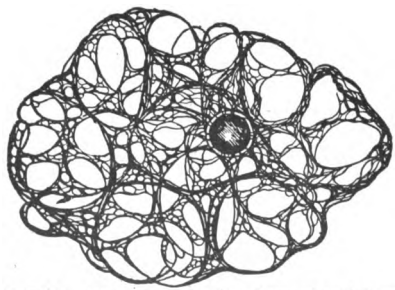
(*b*) Fermentation can be quickly started and greatly hastened by the introduction of a ferment.[a] Thus we are accustomed to hasten the process by the following methods:

1. By adding head yeast to the mixture from which stock yeast is developed.



After Cobb. Atwater, Bul. 112, U. S. Dept. of Agriculture.

FLOUR CELL.

(Highly magnified.)

Notice the bands that must be dissolved or broken before the grains of starch are exposed to the free action of the yeast plant.

2. By adding stock yeast to the mixture from which potato ferment is developed.

3. By adding stock yeast, compressed yeast, dried yeast, or potato ferment to the other ingredients used in the preparation of a sponge or straight dough.

---

[a] A ferment is a form of bacteria or germ that causes fermentation. The term was first applied to the yeast plant, which in its growth, caused the decomposition of sugar into alcohol and carbonic gas. It is also applied to other bacteria, which produce fermentation, as, for example, in milk causing it to sour, or in cider causing it to turn to vinegar. These ferments belong to a class called *organized ferments*; during their growth the fermentation of substances in which they are found takes place.

There is a second class of ferments called *unorganized ferments*. These are chemical *substances* called "enzymes" in whose presence certain fermentations take place without any change whatever in the ferment producing them. In nature we find enzymes in all grains. Thus when a grain of wheat, barley, or oats is moistened and subjected to a certain amount of heat, an enzym, called diastase, appears and

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Fermentation would eventually take place in each of the cases just cited without the introduction of a ferment, but we would not get the lively action desired, in some cases not even the *same kind* of fermentation; sour fermentation is apt to predominate and ruin the dough, sponge, or other mixture.

In the beverage called *malt extract* active ferments do not appear. They are killed by sterilizing before being placed on the market.

Ground malt contains these active elements as well as the sugar and digested gluten produced by them; hence it is a most useful ingredient to be used in making yeast. If, however, it is subjected to temperatures above 160° F. the ferments will be killed; consequently, this ingredient should be added to the flour batter after it has cooled to below that temperature. Enzymes, in contrast to organized ferments, do not "grow" or otherwise change their form while fermentation is taking place, and the reason why fermentation occurs in their presence is not understood. It is said that in certain malt extracts there is sufficient diastase to transform six times its weight of starch into sugar. It reduces the amount of sugar to be used in bread making and adds desirable flavors. For each 100 pounds of flour used in bread making about 1½ pounds of Standard Malt Extract should be used.

In the human body, enzymes are found in the saliva (the element here found is called *ptyaline*), and by its action starch is transformed into sugar. Other enzymes are found in the *pepsin* and *tripsin* of the digestive juices of the stomach, where they perform their important function.

---

causes the starch present to turn into sugar; and another enzym, called peptase causes the gluten to be transformed into a more digestible form. These two elements are necessary for the growth of the germ (baby plant), and nature has ordained that growth shall not take place so long as they exist in a raw state, but by its laws these substances are transformed into digestible forms by the enzymes, in the presence of heat and moisture. Now it is evident that if we produce the necessary conditions in grain we can start the growth of the germ, the starch and gluten being changed into certain forms that are food for the plant.

In making barley malt the germination of the seed is stopped as soon as the transformation has taken place. The plant is killed by drying the grain at a moderate temperature, but the diastase and peptase retain their fermenting power. Malt extract contains these elements in a concentrated form and it presents the appearance of molasses.

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THE DIFFERENT GENERAL METHODS OF MAKING BREAD.

23. **Lactic fermentation.**—If a dough were made without a ferment and set in a warm place, what is called *lactic fermentation* would take place. Acid would be formed the same as in the souring of milk, and the bread baked from the dough would be sour and heavy.

Leavened bread.—Now, if a piece of old dough is left to sour and is then mixed with new dough, both *lactic fermentation* and *alcoholc* (or yeast) *fermentation* would take place. As a result of the lactic fermentation an acid is formed which causes sourness in the bread. (See pars. 54 and 70.) As a result of the alcoholic fermentation carbonic gas is formed, and the bread, although sour, would be light and spongy. The sour dough here referred to corresponds to the *leaven* ("left-over" dough) of Bible times.

Salt-rising bread.—Suppose we make a stiff batter of hot milk and corn meal and let it stand in a temperature of blood heat for several hours, when it will have become fermented throughout. Now make a stiff sponge with warm water, to which considerable salt has been added; mix thoroughly with the corn-meal batter, and allow to rise as usual before baking. In this case a spontaneous alcoholic fermentation is set up and the bread produced would be light and good, but it is not liked by many people, and it does not keep well. This is called salt or milk-rising bread. This manner of making bread is not entirely satisfactory for all purposes. Salt-rising bread is not generally liked as a regular diet.

Yeast bread.—Making bread by using yeast as a ferment is the best method known, and it is probably the only one that you will have to put into practice in the post bakery. In making yeast bread, alcoholic fermentation alone (or accompanied by slight acid fermentation) takes place, and the carbonic gas, rising toward the surface, is retained within the dough by the tenacious gluten, and a light spongy loaf is formed.

If, however, fermentation is allowed to proceed too far, or in a temperature much above 90° F., a change to acetic fermentation takes place, an acid is formed, and sour bread is the result. (See pars. 49 and 55.)

24. **Necessity for light, spongy bread.**—Take a small piece of fresh bread, bread that is less than twenty-four hours old, and roll it in the hands until it forms a solid mass. This is practically the condition

and

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of fresh or heavy bread when it is swallowed. On account of its indigestibility it rests like a heavy weight in the stomach; the juices can not penetrate and digest it. In order that bread can be digested, something must be done in order that the juices may come in contact with all the particles that compose it.

Place the mass in water and only the particles you see on the surface become wet. Now, if it were spongy, the water would penetrate it at once and come in contact with particles throughout the mass. Just so it is with light, spongy bread that is at least eighteen hours old. The digestive juices easily penetrate to all parts of the masses swallowed, and the conversion of starch into sugar goes on throughout the masses at the same time. A piece of candy placed in the mouth will disssolve very slowly; crush it into powder and it will soon be gone. This is exactly similar to the action of the digestive juices upon a gummy piece of bread as compared with one that is light and spongy and crumbles into small particles during the process of mastication.

25. *Gluten* and *starch* must be converted into more soluble forms before they can be taken up and used in the system.

This is done to a greater or less degree in fruits while they are ripening on the trees and in some foods during the process of cooking; but in the case of bread almost all of this work must be done by the digestive juices after the bread is taken into the mouth.

Hence, we see that the art of making bread consists largely in producing a light, spongy loaf. In addition, the bread must be palatable, being properly seasoned and flavored. Bread is the most important of foods and the cheapest article of diet. The more flour and bread used in the company kitchen, the cheaper will be the running expenses of the mess.

Hard bread is made from water and inferior flour, with a little salt added to make it more palatable. Hot cakes and dumplings furnish altogether too much of the gummy masses spoken of above. Good bread is in a class by itself, and post bakers fill a most responsible position in supplying this most important component of the army ration.

(B) THE GROWTH, CULTIVATION, AND USE OF YEAST.

26. **Wild yeast and other microscopic plants in the air.**—Floating about in the atmosphere at all times are found certain *spores* (minute

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particles capable of reproducing their kind) which multiply rapidly wherever they find lodgment under conditions that favor their growth. These conditions are *suitable food*, *warmth*, *moisture*, and *atmosphere*. Air is not essential, but hastens the process.

The spores here referred to are the active agents in fermentation, and are at all times found mixed with flour, grain, and particles of food from which the air has not been excluded.

Yeast is but one of the various microscopic forms of plant life found in the air, and in this state it is called "*wild yeast*."

27. **What results from the growth of certain of these spores.**—(*a*) Certain of the spores above referred to find conditions suitable for their growth in *cider*, and if they develop here an acid (acetic acid) will be formed, changing the cider into vinegar. In this case "acetic fermentation" will be said to have taken place.

(*b*) Certain spores develop in *sweet milk*, producing *lactic acid*. The milk sours and "lactic fermentation" is said to have taken place.

(*c*) Now if spores of "*wild yeast*" find lodgment in food suitable for their growth and the proper conditions of moisture, warmth, and air exist, they will grow, quickly reproducing themselves and during this process feed upon the starch and sugar present, transforming it into alcohol and carbonic gas. "Alcoholic (or yeast) fermentation" will then be said to have taken place.

Many other microscopic plants floating in the air find their way accidentally into surroundings that favor their growth, and in each case a certain kind of fermentation peculiar to that plant results.

28. **Cultivation of the yeast plant.**—If we mix up certain ingredients and produce conditions suitable to the growth of the yeast plant, we find that it will soon develop. We do this frequently in making "*head* (maiden or virgin) *yeast*." *Other kinds of fermentation may also be set up accidentally* and produce acids, so that the action of the yeast in bread making will be more or less ununiform (variable) and unreliable, and sour bread will result without apparent cause.

In the preparation of *compressed yeast* (such as Corbey's, Fleischmann's, Spielmann's, Riverside, and Red Star) a pure culture of the yeast plant has been made—that is, the spores producing acids have been eradicated, so that more uniform results are secured by its use than when a chance is taken of the accidental fermentation that may be set up in the dried compressed yeast or in yeast of our own manufacture.

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Yeast can not *grow* except in the presence of a certain amount of moisture. While in a dry state it will lie dormant for an indefinite period. Many different commercial companies take advantage of this fact and prepare a *dried yeast* that will keep for several months if not exposed to a moist atmosphere. It is generally supplied in the form of square or round cakes of granular appearance and can be prepared by any baker. The method of preparation is fully explained in paragraph 40.

29. **Yeast in bread.**— *Yeast* feeds largely upon sugar, but sugar alone does not contain all the elements necessary to its growth. Certain *albuminates* and *phosphates* are also necessary, and these are found in the food prepared for the reception of the yeast plant. Incident to its growth, considerable sugar is decomposed into alcohol and carbonic gas, and "alcoholic fermentation" is said to have taken place. The carbonic gas forms in pockets and cells throughout the dough, causing it to rise and expand and producing the desired cellular structure. It finally escapes from the bread, upon which it produces no chemical change whatever.

30. Much more sugar (or starch) is decomposed than is necessary for the growth of the yeast plant, and it is on account of using up so much of the nutriment in the flour that efforts have frequently been made to discover some other process of producing the cellular structure in bread. As a result we have the "*aerated process*" of making bread, and others in which baking powder and other chemicals are used. Both of the latter methods have their advantages and are used to considerable extent. The great convenience and saving of time effected by using *baking powder* in making biscuits, etc., is familiar to all, but in its use certain compounds are formed and left in the bread, are said to be more or less injurious if used contiuously.

(C) INTERESTING NOTES ON YEAST FERMENTATION.

31. 1. A solution containing more than one-third of its weight in *sugar* will not be fermented by yeast. Bread can be made without it, but if used it adds an agreeable flavor.

2. Yeast fermentation is *arrested* (checked) when the amount of *alcohol* in the solution reaches about 18 per cent. If the percentage of alcohol present is reduced, yeast fermentation will start up again.

3. Yeast fermentation is *arrested* and the yeast plant killed by strong *acids* or large quantities of salt

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4. Yeast fermentation practically *ceases* at temperatures below 67° F. or above 95° F.

5. In *liquid yeasts* or *compressed yeasts* the plant is *killed* by freezing or by a temperature of 158° F., but the *dried yeasts* are not so easily injured.

6. *Air is not essential* to yeast fermentation, but greatly favors it.

7. The total amount of starch, etc., lost as a result of yeast fermentation amounts to about 2 per cent of the flour used.

8. The *alcohol* resulting from yeast fermentation assists in producing the cellular structure in bread, when it is vaporized during baking. Most of it escapes into the oven, but a small amount (about 0.3 per cent) remains in the bread. In stale bread this is reduced to about 0.15 per cent.

9. *Hops* are not a *necessity* in the preparation of yeast; they are not a food for the yeast plant, but rather check sour fermentations and permit the yeast to work.

10. Lard is used in bread to prevent it from drying out and to give a superior flavor. If used in larger proportions than given it retards fermentation very perceptibly.

11. The most favorable temperature for yeast fermentation is 80° F. For preservation yeast should be kept below 55° F.

(D) THE INGREDIENTS USED IN THE PREPARATION OF YEAST AND THE PROPERTIES OF EACH.

CLASSIFICATION.

32. (*a*) **Dried yeast** (or desiccated yeast), also sometimes erroneously called "dried compressed yeast," such as Magic Yeast, Hart's Yeast, Ralston's Yeast, Yeast Foam, etc. It is generally made in square or round shapes, of granular appearance, and sold in pasteboard packages. If hermetically sealed, it will keep in good condition for several months, and hence can be taken and used anywhere. It gives best results in the sponge and dough process. Its action will be greatly stimulated by the addition of about 2 pounds of cane sugar per 100 pounds of flour used, or better yet by 5 pounds of boiled and mashed potatoes placed directly in the sponge.

Not being a *pure culture* like the *compressed yeast*, it does not give the same uniform and reliable results.

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(*b*) **Compressed yeast** (sometimes called "moist compressed yeast"), such as Corby's, Fleischmann's, Spielmann's, Riverside, and Red Star, in which a *pure culture* of the yeast plant is made and mixed with a certain proportion of starch to give it a body. It is pressed into blocks about the size, shape, and color of butter bricks, except that it may have less color. It is very perishable and spoils quickly when removed from cold storage and exposed to a warm temperature, and for this reason can be used at posts distant from the railroad and in the field only when careful arrangements are made for its cold storage. *If wrapped in heavy paper when removed from cold storage, or if placed in a moderately cool place, a basement, a hole in damp ground, or a porous jar covered with wet cloths, compressed yeast will keep for a number of days.* If well chilled, it can be shipped almost any distance in a "fireless cooker." It may keep for weeks if submerged in cool water. When required, the water should be poured off and the desired amount spooned out.

(*c*) **Liquid yeasts.**—*Stock yeast* (or flour yeast) and *potato ferment* (or potato yeast) are the most common yeasts prepared by post bakers. (See pars. 36 and 37.) These are really old-fashioned yeasts, and are generally considered as out of date or behind the times, and they have been almost entirely displaced by the compressed yeasts, which are great savers of time and trouble and a boon to those who do not or can not make liquid yeast. Liquid yeasts are, however, a great stand-by of army bakers, who have to make bread under any and all conditions, and the ingredients for making them are always obtainable through the commissary.

Rice and *bean yeasts* have their advantages, and formulas for their preparation are also given. (See par. 39.)

It would be difficult to state positively exactly what process of making liquid yeast is the best. Yeasts that produce equally good results are made in accordance with methods which first appear to be quite different, but which in reality amount to practically the same thing. In order to make yeast, all we need is a suitable food, moisture, and the proper degree of warmth. Free access to the air assists in its growth, and if hops, salt, or ginger are added certain undesirable acid fermentations are checked, thus preventing sourness in the bread and at the same time adding certain agreeable flavors.

The starch used in the preparation of yeast food, whether from the potato or flour, is found to be in minute cells covered with a thin

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membrane. This membrane is in practice dissolved or ruptured by contact with scalding hot water (water about 160° F. is sufficiently hot) before the introduction of the yeast, which, in liquid forms, is killed by high temperature. It really makes no difference whether the potatoes are boiled and mashed or whether they are grated raw and then mixed in boiling hot water.

Similarly the flour batter may be added to the hop tea, which should not boil thereafter; or, the batter may be made by adding sufficient hop tea to dry flour, and the remainder of the hop tea immediately thereafter, or when both it and the batter have cooled to a temperature below that at which the yeast plant is killed (preferably about 90° F.). The stock yeast should be added at this time. The only advantage of the second method is that the preparation is reduced to a working temperature in a short period. If ground malt is used in making the yeast, it should not be added to the latter until it has cooled to a temperature below 160° F. A higher temperature than this would kill its active element (Diastase, 22*b* note) which transforms starch into food for the yeast plant.

If these simple facts are borne in mind, much of the mystery connected with the making of yeast is removed. It is the ignorant baker who condemns all methods of making yeast except that followed by himself.

PROPERTIES OF THE INGREDIENTS USED IN MAKING LIQUID YEAST.

33. (*a*) **Hops** do not furnish food for the yeast plant, but they add a pleasant flavor. Their greatest usefulness, however, lies in the fact at they contain than element (called *lupulin*) which is active in checking the acetic and lactic fermentations that generally accompany the alcoholic fermentation which always takes place as an incident to the growth of the yeast plant. To extract this active agent (lupulin) from hops, place them in water (temperature immaterial), and allow it to boil for about ten minutes (fifteen minutes in the case of very fresh hops). Longer boiling will extract a bitter flavor. One-half ounce to 1 ounce of fresh hops to each gallon of water should be used, or generally twice this amount of compressed hops according to their strength as found by experience. The resulting liquid is commonly called "hop tea." If it is desired to make the whitest bread possible the hops should be strained out. If they

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are left in the solution they make it a trifle darker and small pieces of the hops may be found in the bread. For the purpose stated hops surpass any other ingredient used in the food for the yeast plant.

The best hops are of a bright color, between yellow and green. Yellowish-brown hops are old and require less boiling. Brown hops are generally unfit for use.

(*b*) **Salt.**—Salt may also be added to check undesirable acid fermentations that may set up accidentally in the yeast. In the absence of hops salt is always used and generally in addition to them. The amount is from 1 to 2 tablespoonfuls to each gallon of water. Used in small quantities, salt renders fermentation more uniform, thus giving a more even grain to the loaf. In larger quantities salt would retard yeast fermentation. Salt is a necessity in bread making—not only on account of the property just cited but in order to make the bread more palatable. It is generally added when making the dough, about 3 ounces to each gallon of water used in making the bread. The quantity of salt should never exceed 1½ per cent to 2 per cent of the weight of the flour used.

(*c*) **Potatoes.**—Chemists tell us that the potato furnishes the best form of starch for the growth of the yeast plant. Yeast made from it ripens quickly but does not keep so long as flour yeast. The bread resulting is light and sweet and does not dry out or sour so quickly as that from other yeasts. Old potatoes contain more sugar than new ones and should be used in the preparation of this yeast.

As a matter of economy of time and material the potatoes may be washed clean and boiled with their jackets on and finely mashed in a portion of the water in which they were boiled, the remainder being added later. If this water is much discolored clean boiled water should be used. To produce equally good yeast that will make whiter bread the potatoes should be pared before boiling. Some bakers pare the potatoes and grate them and afterwards mix in boiling hot water. The final result is the same—the starch cells are broken and the starch is exposed to the action of the yeast.

(*d*) **Flour.**—Flour is used in the preparation of yeast—to furnish starch, albuminous matter (gluten), and phosphates for the growth of the yeast plant. It should be strong in gluten—a deficiency in starch should be made up by the addition of sugar. Cane or malt sugar is best. The granules of starch are bound together into cells by means of fibrous bands. To rupture these cells and expose the

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starch to the action of the yeast the application of hot water is necessary. This process is generally called "scalding" the flour.

(*e*) **Malt.**—Although barley, oats, wheat, corn, and rice are all capable of being "malted" as the expression goes, the term *malt* is generally applied to *barley malt*, and it is this kind that is used in connection with making yeast. It is the crushed barley that has first been allowed to germinate (grow) in warm, moist rooms of even temperature for two or three weeks, the grain then being dried at a moderately low temperature and crushed. Malt contains certain elements (diastase and peptase) which induce a change of starch and gluten into other forms more favorable to the growth of the yeast plant, and the formation of alcohol and carbonic gas incident to its growth. (See par. 22, *b* note.) As noted above, oats can be malted and used the same as barley, but generally facilities are not at hand in a post bakery to "malt" either one, and as a substitute oats may be ground moderately fine in a coffee mill, soaked in lukewarm water for an hour or more, and then quickly dried or lightly parched in an oven. If treated in this manner they will not contain the active elements found in malted grain, but for the purpose of preventing scalded flour from lumping they will do very well. Even bran is good for this purpose, though it will be of little or no use as a food for the yeast plant. In practice we also get good results by scalding the flour and malt together, but it is probable that the flour and malt mixture drops below 160° F. before the elements referred to have been greatly injured.

(*f*) **Malt extract.**—Malt extract contains these important elements (diastase and peptase) in a more concentrated form, and by diastase companies several different grades of it have been so prepared as to be best suited to the different qualities of flour that may be used in bread making. The quantity used depends upon the particular brand and strength. It is used as a substitute for sugar and to give an agreeable flavor to the bread. Its general use in the army is not recommended.

(*g*) **Sugar.**—During the growth of the yeast plant sugar is decomposed into alcohol and carbonic gas. When the bubbles of gas rise to the surface we say that the yeast has begun to "work." Sugar may be used as an ingredient of the mixture prepared for the growth of the yeast plant; if so, cane sugar, malt sugar (or maltose), or glucose is best. However, it generally appears in the yeast food first

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in the form of starch. During the process of fermentation it is transformed into sugar and then decomposed into alcohol and carbonic gas. (See pars. 6, 7, and 27–c.)

(*h*) **Water.**—*Fresh soft water* should be used in the preparation of yeasts and doughs as far as practicable. Long boiling of water removes the *air* which promotes fermentation.

Salt water (that is, sea water) may be used in the preparation of doughs and sponges, no salt being added to the mixture.

Hard water retards the working of yeast.

Note: Porcelain and granite ware.—Porcelain or granite ware should, if practicable, be used in boiling hops and potatoes, as tinware or iron will cause the hop tea or potato water to take on a darker color, and the bread produced will not be as white as it otherwise would be. Clean hard wood, glass, or porcelain-lined receptacles should be used for yeast, as otherwise certain chemical action might take place that would either darken the solution or spoil it altogether.

34. **Résumé.**—For the growth of the yeast plant we must have certain *albuminous matters* and *phosphates* (see par. 29), and in addition *starch*, which is transformed into sugar and converted into alcohol and carbonic gas, incident to the growth of the yeast plant. Boiling-hot water must be added to the mixture in order to rupture the starch cells and expose the starch used in fermentation. After the solution has cooled to about 90° F. we have a proper food for the development of the yeast plant, and fermentation may take place spontaneously if the solution is left undisturbed in a moderate temperature. In this case "head yeast" would be formed, but if a yeast is introduced to start the fermentation the solution is said to be "*stocked*," and the yeast resulting is called "stock yeast," or "potato ferment," according to the ingredients used. The livelier the yeast introduced the stronger will be the yeast which results. In addition to the food for the yeast, hops, salt, or ginger should be introduced to check the acid fermentations that would otherwise set up and spoil the yeast. Many different formulas for preparing the yeast bring about the same result.

(E) RECIPES.

35. **Head yeast (maiden yeast or virgin yeast).**—Ingredients (6 quarts). 5 quarts of water; ½ ounce fresh hops (see par. 33–a); 10 ounces of malt (see par. 33–e); 1¼ pounds of flour (see par. 33–d).

Put the water on the stove; add the hops, and boil for about eight or ten minutes. This preparation is known as "hop tea." Mix the

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dry flour and malt together in a keg or other suitable receptacle; add sufficient boiling-hot "hop tea" to make a medium thick paste and mix well. (See par. 33-d.) Strain the remainder of the "hop tea" into a separate jar or keg and set both aside until they have cooled to about 80° or 90° F., then pour the "hop tea" into the flour and malt mixture. Set in a warm, even temperature; in about twenty-four hours spontaneous fermentation will have set up and foam will be seen to gather on the surface, a deep light scum will rise and a strong beer odor will be present. In about forty-eight hours the scum will begin to settle and soon thereafter will disappear from the surface of the liquid. The yeast is ready for use as soon as it begins to settle. It should now be set in a cool place, where it will keep from eight to ten days.

Head yeast is developed spontaneously from *wild yeast* (that is, yeast spores found floating about in the air) and is generally prepared only as a starter for a stronger yeast. It may, however, be used directly in the dough or sponge the same as stock yeast. If other yeasts are at hand there is no necessity for its preparation. It is possible to get good results by omitting the hops and malt, but in case they are omitted about 1½ ounces of sugar and 1 ounce of salt per gallon of water should be added.

36. **Stock yeast (or flour yeast).**—*Ingredients* (7 gallons): 5 gallons of water; 2 ounces of fresh hops (see par. 33-a); 2½ pounds of malt (see par. 33-e); 5 pounds of flour (see par. 33-d); 3 quarts of head yeast.

Prepared in exactly the same manner as head yeast, except that the mixture is stocked (head yeast is added) when the cooled hop tea is added to the flour and malt mixture. On account of having the head yeast as a starter, this preparation will begin to ferment at once and it will be ready for use in about twenty-four hours.

In the absence of hops and malt, salt and sugar should be substituted as noted in paragraph 35.

Stock yeast may be used directly in the sponge or dough in the proportion noted in paragraph 52-i, but *its chief function is in stocking the preparation for making potato ferment*, though in its absence, any other yeast would do as a starter.

37. **Potato ferment (or potato yeast).**—*Ingredients* (30 gallons): 24 gallons of water; 28 pounds of sound, well-matured potatoes (par. 33-c); or 14 pounds of desiccated potatoes, or 9 pounds of potato flour; 5 pounds of flour (par. 33-d); 8 quarts of stock yeast, or 8 ounces of compressed yeast, or 20 ounces of dried yeast.

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Wash the potatoes thoroughly and let boil in about 6 gallons of water until well done (par. 33–c). Drain off the water into 2 buckets. Put the potatoes in a clean barrel and mash well, then add 5 pounds of flour and 1 bucket of the potato water (to break the starch cells of the flour), and mix thoroughly. (If using desiccated potatoes, place in a boiler with sufficient water to cover them and boil until thoroughly done; if using potato flour it is thoroughly mixed with the wheat flour and scalded.) Add the remainder of the potato water and about 18 gallons of fresh water at such a temperature that the mixture will be about 85° or 90° F.; add 8 quarts of stock yeast (or the quantity of compressed yeast or dried yeast noted above) and stir for a few minutes. Let it remain undisturbed in a warm, even temperature. The preparation will begin to ferment at once and in a few minutes bubbles will be seen rising to the surface. In about six or eight hours the scum will begin to settle and the yeast will be ready for use. *Always stir well and strain through a colander before using.* Set in a cool place and it will keep from five to seven days.

Potato ferment, or *potato yeast* (see par. 36) as it is sometimes called, produces as good bread as can be made, but it works quickly (see pars. 52g and h, 53c and d) in the sponge or straight dough and must be carefully watched. In making it, great cleanliness is necessary, as acid fermentations may set up from obscure causes and produce sour bread. (See par. 70.) It is best to have two sets of utensils, in order that one set may be thoroughly cleaned while the other is in use. Potato ferment is the form in which liquid yeast is generally used in making bread and generally it should be made fresh each day for use the next.

38. **Tuba de nipa,** as it is commonly called by the Filipinos, furnishes an excellent substitute for stock yeast. It is the sap collected from the *nipa palm.* The sap, having been placed in a deep can with a small exposure, is set in the sun for about twelve hours and allowed to ferment. A thick scum forms on the surface and the *tuba* is removed to a cool place where it will keep for several days. The scum should be allowed to remain on the *tuba* as a protection against contamination.

Fermented tuba de nipa is used as stock yeast and in the same proportions.

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(A) CAPTAIN RENNISON'S INDIAN YEAST (FOREZOPORE YEAST).

39. In handling this yeast it is first necessary to prepare a head yeast by using ground rice.[a] At the end of forty-eight hours it is ready for use in a so-called "sponge." After the "sponge" is ripe a "renewed yeast" is made, using a certain amount of the so-called "sponge" as a starter. Thereafter the ground rice is not used, but a "sponge" is set from a "renewed yeast" made daily.

It is recommended that three iron kegs be provided, if possible, in order that the "renewed yeast" may be three days old when used, the "renewed yeast" being started each day (though a "renewed yeast" started at 6 a. m. may be used at 10 p. m. the same day). Where iron kegs have not been obtained, beer kegs have been found satisfactory, if provided with an iron bung in place of a wooden plug, which would be blown out on account of the gas pressure. The rice may be ground in a coffee mill, but boiled rice has been found to work equally well.

Generally it is best to set the so-called "sponge" at about 10 p. m. The dough may then be made up at about 6 a. m., and the bread will be ready to bake at about 10 a. m. In the absence of rice, beans are said to be a good substitute, though from our experiments yeasts made from them are apt to sour more quickly.

To prepare the head yeast (for a 100-pound dough).—1¾ pounds of rice (or beans); 1⅞ pounds brown sugar (native Philippine preferred); 1¼ gallons water, about 80° F. Mix the ingredients well, pour into a keg, and cork down tightly. Shake every hour or so—the more the better. In forty-eight hours it will be ready for use.

Setting the "sponge."—Sift the flour (100 pounds) into the trough. Hollow out the center and pour in the yeast and gradually mix in enough flour from the sides to make a thin batter. This so-called "sponge" should be ready in about eight hours.

(B) RENNISON'S FORMULA, MODIFIED SO AS TO USE WHEAT FLOUR IN THE PLACE OF RICE.

Take 2 pounds of brown cane sugar, 2 pounds of wheat flour, and 2 gallons of water, about 80° F. Mix thoroughly and allow to stand

[a] In recent experiments equally as good and even better results have been attained by substituting wheat flour for the rice flour here used.

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for about forty-eight hours, when it will be ready for use. (Use a closed jug, and do not shake.)

Sift 50 pounds of flour into the trough, and hollow out in the center, pouring in the yeast. Gradually mix in enough flour from the sides to make a thin batter, and then dust lightly with flour.

Let stand for about nine hours.

Dip out 4 pints of the yeast for renewing the process, and then proceed to make the dough from the remainder by adding 10 ounces each of salt, sugar, and lard, and about 2 gallons of water, so as to make a slack dough. Allow to prove for about three hours and mold into loaves, allowing them to prove for about two hours. Then bake.

Renewing the yeast.—To renew the yeast, mix the sponge dipped out with 2 pounds of cane sugar, 2 pounds of wheat flour, and 2 gallons of water, and let stand in a temperature of 80° F. for about fourteen hours, when it will be ready for use.

The amount of yeast prepared is sufficient for a 100-pound dough. In preparing it dip out the 4 pints of sponge each time for renewing the yeast, which need not be started fresh so long as the process is continuously used.

This process has given excellent results—far better than "Indian yeast" proper. The renewed yeast seemed to improve from day to day when the process was used continuously

(*Renewing the yeast.*—When the "sponge" is ripe, dip out 1¼ pints; mixing it with 1¼ pounds of brown sugar (native) and 1¼ pounds of flour, to which 1¼ gallons of lukewarm water has been added. Pour this mixture into the iron keg. Cork down and shake well—the more the better. This yeast should be ready in about eight hours, but, as before stated, will be better if not used for two or three days.)

Making the dough.—The "sponge" being ripe and a portion dipped out for the "renewed yeast," the dough is made up the same as usual.

Advantages.—The advantages claimed for this yeast are that, on account of the benefit derived from shaking, it can be transported by pack or otherwise. It has kept as long as sixteen days. It is said to be unaffected by climate, thunder, or ordinary variations of temperature. It is very cheap, and the ingredients are generally obtainable. The results obtained in the Tropics have been quite uniformly successful, and its use has been greatly appreciated where other yeasts could not be obtained. For unknown reasons the results obtained in the United States have not generally been equally as good.

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40. *Dried yeast.*—Dried yeast is very easy to manufacture, and can be made with facility by any baker. If made from the potato ferment, the results obtained at the training schools have been better than those obtained when using the commercial product, probably for the reason that such yeast is fresh or of known age.

(*a*) *Dried yeast from potato ferment.*—Make a potato ferment according to formula given, using compressed yeast as a starter in preference to stock yeast or dried yeast. After working pour off the supernatant liquid, disturbing the sediment as little as possible. Take 1½ gallons of sediment, 13 pounds of corn meal, and 1 ounce of cooking soda, and mix into a stiff dough. Shape into cakes about half an inch thick and 2½ inches square, drying at a temperature of about 60° F. or less.

This mixture makes about 15½ pounds of dried yeast, and it has been found to be superior to any purchased on the market.

(*b*) *Dried yeast from stock yeast.*—Make a stock yeast according to formula given. After working, pour off the supernatant liquid, disturbing the sediment as little as possible. Take 1 quart of sediment, 2½ pounds of corn meal, and ½ pound of flour, and mix into a stiff dough. Shape into cakes and dry as above.

This mixture makes about 3 pounds of dried yeast of excellent quality, but hardly equal to that prepared as in the preceding paragraph.

(*c*) *Dried yeast from a sponge* (Dunne's formula).—Take one-half gallon of water and 6 ounces of hops, boil for fifteen minutes and strain through a colander. Add 12 ounces of sugar and 3 quarts of potatoes, peeled and sliced, to the hop tea, and boil until the potatoes fall to pieces. Then beat with a wire whip until smooth, add 12 ounces of flour, by mixing to the above while it is still hot enough to scald it—that is, above 160° F.

Start work at 3 p. m. About 8 p. m. (or after the mixture has cooled to below 90° F.) stock with one-fourth pound of compressed yeast, adding 1 pint of lukewarm water, or substitute 8 ounces of dried yeast, adding 1 quart of water. If practicable, use a 6-gallon crock. Take a clean brick and stand on end in the yeast, setting a saucer of water upon it. Cover the crock with a tight lid—the idea being to produce a very moist atmosphere. Set in a temperature of about 80° F. until it rises and falls once—say, about ten hours. Then add flour, making a soft sponge, adding no more water at this

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time. In from three-fourths of an hour to one hour this will rise and fall. Then add more flour, making a slightly stiffer sponge. This will rise and fall a little quicker than before. Twice more repeat this process of adding flour, each time making a little stiffer mixture—the last dough being *very stiff*.

After the last proving roll out the dough to about one-eighth of an inch in thickness (so that it will dry quickly), dusting with corn meal. Cut into pieces about 2 inches square.

Dry at a temperature of from 50° to 60° F., spreading the squares of dough on boards that have been well dusted with corn meal, and turn the cakes once a day. If a good current of dry air is allowed to pass over the drying mixture, it will be ready for use or storage in about three days.

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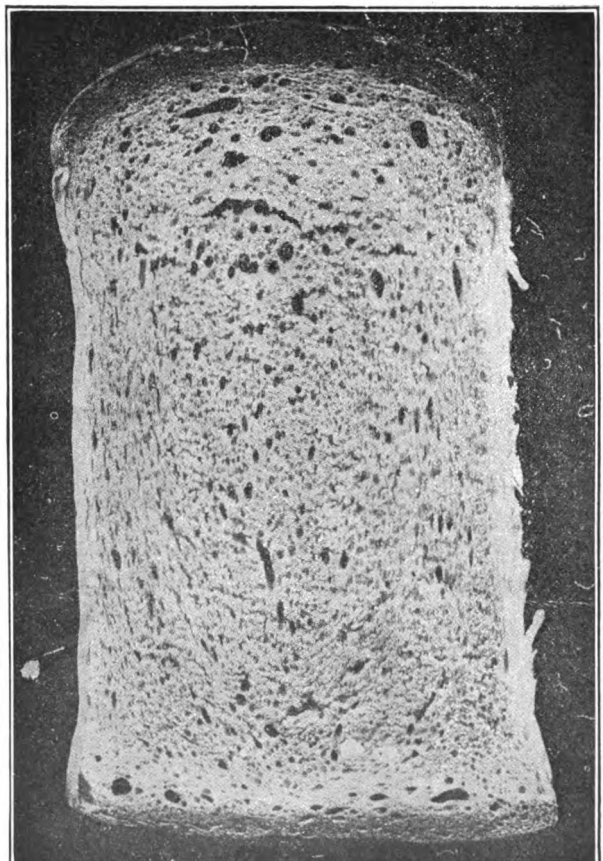

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Showing cellular structure and proportions of a well-formed loaf.

CHAPTER III.

BREAD.

GENERAL CLASSES.

41. There are two general classes of bread:

(*a*) **Fermented bread.**—This includes all breads made *with yeast*, such as issue bread, graham bread, rye bread, and all rolls made with yeast.

(*b*) **Unfermented bread.**—This includes all breads made *without yeast*, such as aerated bread, hard-tack, crackers, baking powder biscuits, etc.

GENERAL METHODS.

42. There are two general methods of making bread:

(*a*) **By the sponge and dough process**, in which a *sponge* is first set, by using one-half of the flour, about four-sevenths of the water, and all of the yeast, and incorporating all the other ingredients in a second operation some time later, when the dough is made. *The sour-dough process, or left-over process*, is a modification of the sponge and dough process. (See par. 54.)

(*b*) **By the straight-dough process**, in which all of the ingredients are incorporated in one long process of mixing and kneading rather than in two short ones, as in the sponge and dough process.

43. **General remarks.**—In preparing the sponge or dough the temperature of the ingredients used and of the bakery should average about 80° F. (about 78° F. in summer and 82° F. in winter). Even experienced bakers should take the temperature of the flour and atmosphere with the thermometer and regulate the temperature of the water so that the sum of the three temperatures will be very close to 240° F. We must, however, also consider what effect the

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outside temperature may have upon that of the bakery during the proving. If the bakery is likely to be chilled, the sponge should be set a little warmer than usual; if the nights are very warm, the sponge should be set with cooler water. Sometimes it may be necessary to add small chunks of broken ice. Very hot water should not be used, as it will kill the yeast. (Pars. 31–36.)

If the flour is cold, it must be left in a warm place for a time before using. Several hours before it is time to set the sponge the flour may be sifted and spread in the open trough and stirred and turned over from time to time, to expose all portions of it to the warm atmosphere.

Considerable heat is generated as a result of fermentation during the proving of a dough or sponge, and the trough should be well covered to retain this heat; and in addition, in the case of the dough, to prevent currents of air from circulating over the surface, as this would cause the formation of a crust unless the dough has been well greased.

44. *Great care must be exercised in mixing* in order to distribute the yeast equally throughout the sponge, to break up any lumps that may have formed, and to allow the air to come into contact with all parts of the mixture, as the presence of the oxygen (in the air) assists in fermentation.

Careful and thorough kneading of dough and molding of loaves ruptures all large bubbles that have formed and further distributes the yeast to every part and insures an even texture. Careless and indifferent work or *insufficient kneading* are apparent to the careful observer in examining the crumb of the bread produced. It will be "coarse grained" in appearance and of very ununiform cellular structure.

45. If the dough has been properly handled and baked, the tops of the loaves will present a nicely rounded and browned appearance and the crumb a uniform cellular structure. The color of the crust is regulated by the amount of sugar present and the temperature of the oven. A pale loaf results from an absence of sugar or a very "slow oven."

Sometimes the tops of the loaves present a flat appearance. This may arise from various causes.

First, if the yeast of the sponge is young, the loaves will be flat on top, large holes will be observed for an inch or so underneath the

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top crust, the crust will present rather a reddish-brown appearance, and the crumb will be of a dull, grayish color.

Second, if the flat top is accompanied by a good color and normal cellular structure, the dough was too soft.

Third, if the top is flat and dents and wrinkles appear in it, the dough was overproved and the crumb will be dark and crumbly. A coarse cellular structure is noted, and streaks of dough may result from a shaking down through careless handling of the pans before the framework is fixed.

A long fermentation produces certain acids that act directly on the gluten, weakening the cellular walls and rendering them delicate and easily ruptured.

46. When a new brand or grade of flour has been received, or if there is doubt as to the quality or strength of yeast used, or if the bakers are inexperienced, no attempt should be made to turn out large batches of bread or to use the straight-dough process at once. A small sponge should be set, as any yeast, and especially a weak one, will work better in a moderately thin sponge than in a straight dough, and if the batch of bread is ruined the loss of flour will not be so great as it otherwise would.

47. Generally when using the dried yeast, or any yeast of doubtful strength, the sponge and dough system should be used. It is also a great convenience to set a sponge in case graham bread, rye bread, rolls, etc., are to be baked.

48. In civilian bakeries the straight-dough process is used almost exclusively at the present time, and great care is exercised in maintaining an even temperature of about 80° F. for all proving of sponges and doughs. It is said of this process that it requires stronger flour and that a bread of finer cellular structure results; that the bread will keep longer and that it has a finer flavor, and further that a greater number of rations is produced. After comparing the bread produced by this process with that produced (in which the sponge has proved in nine hours or less in a temperature of about 80° F.) by the sponge and dough process, we are of the opinion that the differences noted are largely a matter of fancy, and that for our purpose it may be considered that equally good results are obtained by either method, and that whether the one process or the other is used should be rather a matter of convenience than otherwise. Bread can be produced in a much shorter time by this method and con-

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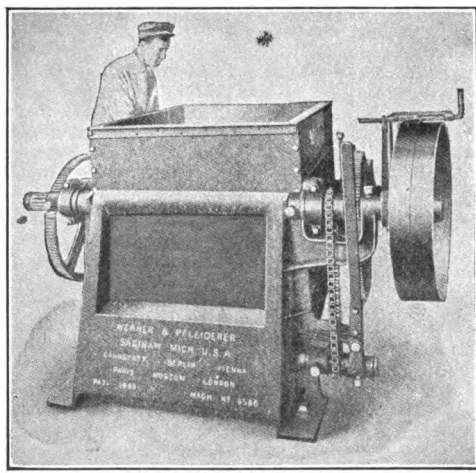
sequently it is the one to be used in the field when short stops are made. In the post bakery it may be used along with the sponge and dough process in order that several runs of bread may be made without interference in the ovens, and the work be done in seasonable hours.



DOUGH MIXER.

In working position.

49. *The sponge and dough process* is, from long habit, the one most commonly used in post bakeries. In following this method we first take one-half of the flour to be used in baking, all of the yeast, and enough water to make a batter of such stiffness that it will scarcely drip from the hand when taken up. This mixture (called the *sponge*) is set in an even temperature of about 80° F. to rise or

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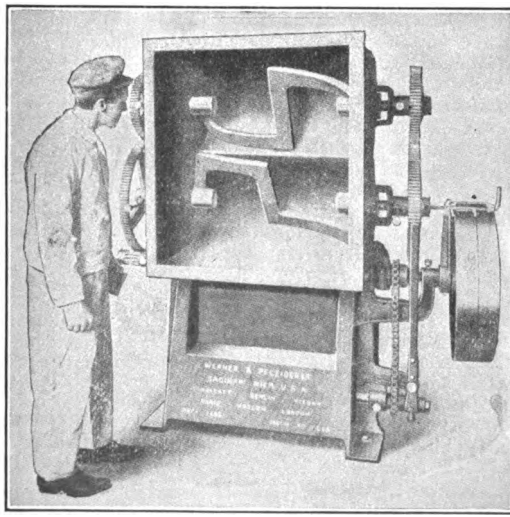
prove. When it has about doubled in volume *bubbles will be seen breaking at the surface*—portions of the gluten having been stretched beyond its elastic strength—and the sponge will begin to fall. It is now said to be ripe and is ready to be worked into dough. It may



DOUGH MIXER.

In tilted position for dumping the dough after kneading.

fall an inch or two without detriment, depending upon the depth of the trough. If not disturbed it may rise and fall two or three times, but if this takes place the dough is liable to sour. (See par. 70.) This is especially true with any yeast except a pure culture. (See par. 28.)

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50. **Kneading the dough.**—Lard, and water in which salt and sugar have been dissolved, are now added to the sponge, which is made into a thin batter. After the sponge is well broken up and no stringy portions remain, the remainder of the flour is added and the whole is mixed into a stiff elastic mass which may be picked up and thrown or carried about at will. One end of the trough is carefully cleaned with a scraper, brushed and then greased with a small quantity of lard. Portions of dough, weighing about 30 pounds, are now cut from the general mass and kneaded until the desired degree of stiffness is attained, and are then piled in the end of the trough just cleaned. The dough should about half fill that part of the trough occupied by it. The partition board is now placed against the dough and is held in position by a sack of flour or other heavy mass. The top of the dough is greased to prevent the formation of a crust, and it is again set in a warm, even temperature to prove. When it has about doubled in size it will begin to fall and should be punched down to free it from the large bubbles of gas that may have formed within. As soon as it has risen again to the same height as before it should be molded into loaves as fast as possible.

51. **General rule for amount of ingredients used in bread making.**—The following general rule should be learned. For each 100 pounds of flour used in baking, about 7 gallons of liquid will be required, no matter what process is used. If the *sponge and dough process*, four-sevenths of it will be used with one-half of the flour in the sponge and three-sevenths in preparing the dough. If the *straight dough process*, all is used at once. *Each gallon of liquid used will take about 3 ounces of salt, 3 ounces of sugar, and 3 ounces of lard.* In setting a sponge or making a straight dough, 1 ounce of compressed yeast or 2 ounces of dried yeast per gallon of water used at that time is the amount generally used, but the times of proving vary inversely with the amount of yeast, and the following table should be consulted:

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52. *Recipes for sponge and dough process.*

Rations of bread desired.	65	125	250	500	Time in sponge.	Time in dough.	Remarks.
Total flour used, pounds	50	100	200	400			
Total water used, gallons	3½	7	14	28			
SPONGE.							
Ingredients:							
Flour.....pounds..	25	50	100	200	9 hours..	.....	
Water.....gallons..	2	4	8	16			
(*a*) Compressed yeast..ounces..	2	3	6	12			
DOUGH (Add to above).							
Ingredients:							
Flour.....pounds..	25	50	100	200	.....	2½ hours.	Results excellent. This formula is recommended for general use in the sponge and dough process.
Water.....gallons..	1½	3	6	12			
Salt.....pounds..	⅝	1¼	2½	5			
Sugar.....do.....	⅝	1¼	2½	5			
Or Malt extract..pints..	½	1	2	4			
Lard (or compound)..pounds..	⅜	1¼	2½	5			

If instead of compressed yeast being used in the proportion given in the preceding recipe, the following kinds and quantities of yeasts be substituted, the times of proving in the sponge and dough, will be about as noted. In summer the amount used may be reduced by about one-fourth.

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Rations of bread desired.	65	125	250	500	Time in sponge.	Time in dough.	Remarks.
Total flour used, pounds	50	100	200	400			
Total liquid used, gallons	3½	7	14	28			
SPONGE.							
Ingredients:							
Flour.....pounds..	25	50	100	200			
Water.....gallons..	2	4	8	16	10 hours.	2½ hours.	Results not as certain as with (*a*).
(*b*) And compressed yeast.....ounces..	1	2	4	8			
(*c*) Or dried yeast (commercial)...ounces..	4	8	16	32	...do.....	...do.....	Results very good.
(*d*) Or dried yeast (from potato ferment), ounces.....	4	8	16	32	...do.....	...do.....	Results excellent.
(*e*) Or dried yeast (from stock yeast), ounces.....	4	8	16	32	...do.....	...do.....	Do.
(*f*) Or dried yeast (Dunne's recipe), ounces.....	4	8	16	32	9 hours..	...do.....	Do.
[a](*g*) Or potato ferment, gallons.....	1	2	4	8	4½ hours.	3 hours.	Do.
[a](*h*) Or potato ferment, gallons.....	1½	3	6	12	3½ hours.	2½ hours.	Do.
[a](*i*) Or stock yeast, gallons.....	½	1	2	4	10 hours.	3 hours..	Results fair to good.

[a] Total amount of *liquid* used is as given in paragraph 51, i. e., about 7 gallons per 100 pounds of flour.

NOTE.—For the method of handling *Indian yeast* (Rennison's formula) see paragraph 39.

Under no circumstances should a sponge be allowed more than ten hours to ripen—a limit of nine hours is better, and for such long fermentations only a *compressed* or *dried* yeast should be made. A sponge set with *potato ferment* should not be allowed more than six hours to ripen. A longer period of fermentation with this yeast is apt to produce sour bread. Short fermentations in the sponge are generally productive of much better results than the longer fermentations which were formerly so common. In any case where *dried*

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yeast is used a more active and reliable fermentation will result if about 5 pounds of potatoes, boiled and mashed through a colander, are added to each 100 pounds of flour used in a sponge.

53. *Recipe for straight-dough process.*

Rations of bread desired.....	65.	125.	250.	500.	Time in dough.	Remarks.
Ingredients:						
Flour.....pounds..	50	100	200	400		
Water.....gallons..	3½	7	14	28		
(*a*) Compressed yeast.ounces..	3	6	12	[a] 24		
Salt.....pounds..	⅝	1¼	2½	5	9 hours...	Results excellent.
Sugar.....do....	⅝	1¼	2½	5		
Or malt extract.....pints..	½	1	2	4		
Lard (or compound).pounds..	⅜	1¼	2½	5		

[a] Sixteen ounces when using mixer.

If, instead of compressed yeast being used in the proportions given in the preceding recipe, the following kinds and quantities of yeast be substituted, the times of proving in the dough will be about as noted:

Rations of bread desired.....	65.	125.	250.	500.	Time in dough.	Remarks.
Ingredients:						
(*b*) Water.....gallons..	3½	7	14	28	5 hours...	Results excellent.
And compressed yeast, ounces.....	8	16	32	64		
(*c*) Or water.....gallons..	2	4	8	16	6 hours...	Do.
And potato ferment....do....	1½	3	6	12		
(*d*) Or water.....do....	2½	5	10	20	7½ hours..	Do.
And potato ferment....do....	1	2	4	8		

Generally speaking, no yeast other than a compressed yeast or a potato ferment is recommended in making straight doughs. In case of necessity, however, dried yeast may be used in double the amount

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indicated in the sponge-and-dough process. To stimulate fermentation, an additional amount of potatoes, about 5 pounds per 100 pounds of flour (see par. 52), should be added or about 2 pounds of cane sugar to each 100 pounds of flour used at the time.

54. (*a*) *Left-over dough process.*—Take 40 pounds of dough from a batch about to be molded into loaves and keep in a cool place (preferably a refrigerator) for the next batch of bread (up to twenty-four hours). Mix this 40 pounds of dough with 26 pounds of flour and about 14 quarts of water at about 80° F. into a sponge and allow to prove as in the regular sponge-and-dough process. (See par. 43.)

When ripe make into a dough by adding 14 quarts of water, 1¼ pounds of sugar, 1¼ pounds of lard, 1¼ pounds of salt, and 68 pounds of flour.

This will produce about 132 rations of bread after keeping out 40 pounds of dough for the next batch.

By this process results have continuously been attained unexcelled by any other method used in the bakery. If impossible to preserve the left-over dough in a cool place, the same method may be pursued, but the results will approach those obtained in the sour-dough process.

(*b*) *Sour-dough process* (*a second-rate method*).—Take 20 pounds of flour, 2 gallons of water at about 80° F., and 3 ounces of dried yeast. Mix into a sponge and let stand for forty-eight hours. Then add 30 pounds of flour, 5 ounces of salt, 5 ounces of sugar, 5 ounces of lard, 2 ounces of baking soda (if practicable), and 6 quarts of water, and mix into a dough. Let rise once only. This will require about three hours. Mold into loaves and continue according to the regular method.

Set aside 10 pounds of the dough for twelve hours. Then make a sponge, using 8 quarts of water and 20 pounds of flour, and allow to rise over night until ripe, and add flour and ingredients as above.

This method should be resorted to only in case yeast can not be obtained in sufficient quantity. The results are not as satisfactory as with yeast, and a sour dough should be started anew every three or four days to get best results.

To make a straight dough.—Let the left-over dough stand for twenty-four hours; then make a straight dough by adding 14 quarts of water, 50 pounds of flour, 5 ounces of salt, 5 ounces of sugar, and 5 ounces of lard. Let prove for four or five hours (until ripe) and mold into loaves, retaining sufficient dough for a new starter.

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55. Remember that the most favorable temperature for the working of yeast and proving of sponge and dough is about 80° F. (say, 78° in summer and 82° in winter). Fermentations at higher temperatures promote acidity and ruin the flavor of bread—the same may be said of long fermentation. Bakers should regulate the length of fermentation in a sponge or straight dough so as to secure the best results and not solely to suit their personal convenience.

56. **Scaling.**—It is customary, especially in garrison, to make issue of bread in 2-ration loaves—i. e., in loaves that will weigh 36 ounces when twenty-four hours old. Single ration loaves should weigh 18 ounces. A 2-ration loaf will dry out from 3 to 3½ ounces while baking and before issue, and this must be taken into consideration in scaling the dough before molding. We have found that a loaf scaled at 39½ ounces weighed 37.2 ounces when withdrawn from the oven and 36 ounces when twenty-four hours old.

In fast scaling, overweight is the rule. In addition a certain amount of moisture is lost during the process of fermentation and prior to scaling, so that each 2-ration loaf may be considered as having resulted from about 40 ounces of ingredients used in making the loaf; each ration from 20 ounces.

Taking the ordinary formula as given in paragraph 51–a, for each 100 pounds of flour used we would attain the following weight of ingredients:

	Pounds.
Flour	100
Water, 7 gallons, 8 pounds per gallon	56
Sugar, salt, lard, and yeast	4
Total	160 or 2,560 ounces.

Dividing 2,560 by 20 we get 128—the approximate number of rations baked from each 100 pounds of flour. The number should differ but two or three from this amount. Each ration would then require 12½ ounces of flour and 5½ ounces of water and other ingredients.

While as a rule the scales should be set at about 39½ ounces, this can be determined accurately only by experiment with the particular kind of flour in use, and sheets of bread should be weighed frequently to see that the scaling of loaves is properly regulated.

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There is a difference in flours as to the amount of water that will be taken up in the sponge and dough and in the corresponding loss while baking and before issue. This difference in flour is due to the amount of moisture it already contains, and to the character and quality of the starch and gluten. Starch is the great absorber of water, but retention of moisture depends upon the quality of the gluten.

57. **Molding.**—The loaves should be molded until firm and free from large gas pockets. The loaf should retain its form until laid in the pan and not gradually spread out into a shapeless mass.

58. **Proving.**—After the loaves have been carefully formed they are placed in bake pans—the number and arrangement depending upon the size and shape of the pans. If too few loaves are placed in a pan, they will have a low "squatty" appearance as though they had not risen properly; if too many, they will be high and narrow, and although they will be of uniform porosity near the top and bottom, large blow holes are apt to appear in the center, where fermentation has continued, without escape for the gas, after the baking elsewhere is well under way.

It has already been noted that up to a certain temperature proving is accelerated by heat. The temperature of the room being greater from the floor toward the ceiling, the pans first filled should be placed on the bottom shelf of the proof rack (or proof box) and the others on the next higher shelves as they are filled.

59. **Proof room and proof box.**—In the larger bakeries, iron racks, mounted on rollers, are provided to receive the pans as they are made ready for the proof room. The *proof room*, free from drafts and heated to a temperature of about 80° F. by free steam, is made ready to receive the racks which are wheeled into it. These facilities are not found in the smaller bakeries and proof boxes are provided instead. The boxes should be practically air tight, and, if proof racks are provided, of proper size to receive them. If proof racks are not provided boxes should be made with shelves of narrow slats to permit free circulation for such steam as may be generated within. Often a pan of water is placed on the bottom shelf, and when the proof box is filled hot bricks are dropped into it to generate steam which should be present during the proving of the loaves. If gas is provided, a better method is to let the jet play upon the bottom of the pan, which is conveniently exposed beneath the box. If

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steam is not provided, the tops of the loaves should be greased to prevent the formation of a crust. (See par. 90.)

If the pans have been properly filled, the loaves should generally occupy about one-half their depth; when they have about doubled in size, i. e., when they are about on a level with the top of the pan, they are ready for the oven.

If the ovens are not ready to receive the loaves, the proving should be checked by lowering the temperature of the proving room or proof box, or by placing them in open air in cool weather. In family kitchens the loaves are sometimes placed in an ice box to accomplish this purpose.

60. **Baking.**—Great care must be exercised to have the ovens ready at the proper time. The proper temperature back in the ovens is from 400° to 450° F., and if a *pyrometer* is not provided, the temperature should be tested with the hand or by putting a spoonful of dough on a tin well back in the oven—it should be brown in five minutes. While filling the oven and for about ten minutes thereafter or longer, depending upon the temperature of the oven, the *oven damper* should be left open to carry off moisture and such dust as may be raised in the oven. Incidentally, the temperature of the oven is lowered very slightly, giving the loaves a better chance to spring up from the bottom before the framework is fixed.

It will be noted that the dough has been proving constantly from the setting of the sponge until the loaves have been placed in the ovens, about doubling in volume in the sponge, dough, and in the loaves. In the oven the change is even more remarkable, as the loaves nearly double in size in from fifteen to twenty minutes. (Pars. 52, 53.)

During the proving process the yeast plant has been growing continuously, and the carbonic gas, liberated as a result of fermentation, has produced the increased size and porous structure. When the loaves are placed in the oven, the heat penetrates to the center, killing the yeast plant and, in consequence, arresting the fermentation, but the gas already formed expands, rapidly increasing the size of the loaf. The loaves should brown in from fifteen to twenty minutes. If the oven is too hot, the crust will become dark and thick and before there has been sufficient time for the dough within to become properly baked the loaves will be heavy; gummy streaks will be found near the center, and large blow holes will have formed within.

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61. *The crust* is formed on account of the intense heat to which the outside of the loaf has been subjected, together with the incident drying out of this portion. Here the gluten is changed into a stiff gum and the starch into a more digestible form. The brown color is due to drying out of the exposed surface and to a certain chemical change in the starch, known as "caramelization." Within the loaf the conditions are entirely different. The crumb near the crust is subjected to a temperature as high as 300° F. or more, being bathed in superheated steam. The temperature grows less as we approach the center, where it seldom rises above 200° F, although maximum dough thermometers have registered as high as 212° F.—the highest temperature of free steam in contact with moisture and not subjected to pressure. Under the action of this temperature the gluten becomes sufficiently stiff to give permanent shape and form to the loaf and to retain the cellular structure even after the gas which has produced it has escaped. From what has just been said it is easy to understand why the crumb of the bread presents such a uniform appearance throughout instead of being baked to different degrees of hardness from the crust toward the center, as one might very naturally expect.

62. The time of baking in a temperature of about 385° F. may be assumed to be about ten minutes for each inch of depth of the loaf, as measured after springing up in the oven.

As it does not take so long for heat to penetrate to the center of the small loaves, it is evident that they can be baked in a much hotter oven than the larger ones, the loaves being subjected to the intense heat for a shorter period. If placed together in the same oven, the smaller loaf will bake in a shorter time; therefore, as a rule, loaves baked at the same time should be of the same depth.

Care must be exercised, especially with overproved dough, not to jar the pans while placing them in the oven, as this might cause the loaves to fall. They will not have time to rise again before the yeast plant is killed, and the bread resulting will show soggy streaks.

63. *To prevent too rapid formation of the crust* many bakers moisten the tops of the loaves with water before placing them in the oven, or arrangements are made to pass steam over the loaves during the process of baking. This causes the loaves to run together in a more compact mass, and it stimulates the tendency to mold, especially in warm damp climates. If the loaves are treated in this manner or if

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they are painted with water immediately after taking them out of the oven, they will present a shiny surface—much the same as is generally present in Vienna bread.

To produce nicely separated loaves and bread of better keeping qualities, in addition to preventing too rapid formation of the crust in the ovens, the loaves may be painted with lard immediately after molding and again after taking them from the oven.

64. **Cooling.**—After removal from the oven, the bread should be placed on edge (preferably on a slat-top table) to permit free circulation of air while the gases are escaping and the bread is drying out, unless iron racks are provided on which to store it until issue. Where conditions require, clean cloths of porous material should be spread upon the loaves to keep off the dust and to prevent flies from spreading infection. Bread, on account of its porous and spongy nature, might easily become a spreader of disease, a point that should be borne in mind by parties carrying bread from the bakery in open wagons. While in transit the bread should be carried in a closed box or crate, or it should be laid on a clean wagon sheet so arranged as to completely cover it and protect it from the dust and flies.

65. **Keeping.**—Where a bread room is provided, the loaded bread racks may be wheeled directly into it. Good ventilation should be provided, and an effort made to regulate the amount of bread on hand so that none need be issued until twenty-four hours old, and generally none should be stored at the bakery more than about forty-eight hours. If bread boxes are provided for the storage of bread, the following method should be followed: After four or five hours the bread may be removed to the cupboards or bread boxes—provision being made for a small amount of ventilation during the first twenty-four hours, after which all chemical changes will have ceased within the loaf. The bread should then be placed in a closed box or closet to prevent further drying out. If kept for several days, it may be necessary to provide bowls or pans of water to prevent further evaporation.

66. **Stale bread.**—When bread is taken from the oven, the crust is hard and dry and breaks with a snap. If tapped with the fingers a distinctly hollow sound will result (providing it has raised well and is properly baked); the crumb is moist and elastic. Within a few hours a large portion of the moisture within the loaf spreads to

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the crust making it soft and tough; the remainder combines chemically with the crumb, giving it the appearance of dryness. When bread has attained this condition, it is said to be *stale*, and until this time—eighteen to twenty-four hours—it is generally considered as unfit for immediate use.

67. **Slimy or sticky bread.**—Sometimes in warm weather bread that is several days old may take on a brown color and have a peculiar taste and odor. The bread becomes sticky or slimy and may be pulled out into strings. This condition in bread is produced by a certain microscopic organism often found in the common potato, and may exist in "potato yeast" or compressed yeasts in which potato has been used in the manufacture. The organism having found its way into the bread, survives the heat of baking and under favorable conditions of warmth and moisture causes decomposition of the bread. As a remedy, keep the bread in a cool, dry place and bake in such quantities that it will not be necessary to keep it on hand for more than a day or two. Scald the troughs once a week and place them in the sun for about two hours.

68. **Rope in bread.**—What is commonly called "rope" sometimes appears in bread that is not more than twelve hours old. The bread can be pulled out into long strings. This condition is also due to the presence of a certain potato organism. It seems to develop in the cracks of wooden troughs, survives the heat of baking, and grows rapidly in fresh bread. Treat as explained in preceding paragraph.

69. **Mold in bread.**—Mold is one of those minute spores that float about in the air and develop wherever suitable conditions of food, warmth, and moisture are found. Hence, when the proper conditions exist for its growth, it will be found to develop either on the outside or inside of bread. In the Philippines freshly baked bread has been known to become moldy in a few hours when transported in canvas-covered escort wagons under the tropical sun; it will be seen that here the moisture escaping from the bread has been retained under the canvas and that with the heat present we have ideal conditions for the growth of these particular spores. The bread must be given free access to dry atmosphere while becoming stale and should then be stored in a cool, dry place.

70. **Sour bread.**—Sour bread generally results from certain acid fermentations that are set up during the proving of the sponge or dough. They may occur as a result of unclean utensils, as, for in-

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stance, in troughs, where the organisms may have developed in cracks that have not been cleaned out, or they may be due to the acetic or lactic fermentations that generally set up after alcoholic fermentation has ceased, as in the case of overproved dough or sponge. Bread may, however, grow sour with age, as frequently happens when the undesirable organisms from the air have taken lodgment, as in the case just cited.

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CHAPTER IV.

SPECIAL RECIPES.

71. The following "**special recipes**" are those now used daily at the Training School for Bakers and Cooks at Fort Riley, Kans., and the quantities of rolls, pies, etc., baked is such as to supply the demands of the post and at the same time does not in any way interfere with the baking of the bread used—about 2,000 rations daily. At all points—especially at a distance from towns—the baking of these articles should be a part of the daily routine, and arrangements should be made to take orders through the commissary and make deliveries in the same manner. Troops should get their pies, etc., at the same time that they draw their bread.

72. **Rye bread.**—Set a sponge, using white flour, as explained in paragraph 49, or dip out as much as may be desired from a sponge set for white bread. The sponge being ready, take about the same amount of rye flour as there was of white flour used in the sponge and mix a stiff dough, using white flour for dusting; add carroway seed as desired. When sufficiently proved, mold into Vienna-shaped loaves scaled at 18 ounces and place in the proof box. When ready for the oven, make about three oblique shallow cuts across the top of the loaf to prevent ragged tears while crusting, and bake from twenty-five to thirty minutes. (See pars. 12 and 62.) The reduction in size of loaf is recommended on account of the increased cost of rye flour. For better quality, increase amount of sugar and lard used.

73. **Graham bread.**—Made in exactly the same way as the rye bread, omitting the carroway seed and substituting graham for rye flour. Mold into loaves scaled at about 19½ ounces and, after proving, bake in single-ration bake pans. Made in the same size as issue bread, graham costing about the same as issue flour.

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74. **Sales bread.**—100 pounds straight dough. Use 75 pounds of issue flour, 25 pounds of family flour, 2 pounds of issue sugar (or, better, 1½ pounds of malt extract, standard, and 1 pound of sugar), 1½ pounds of salt, 1 pound of lard, ½ pound of compressed yeast, 1 gallon of milk, and 6 gallons of water. Make a loaf scaled at 18 ounces and bake in the same manner as graham bread. If a thin crust is desired, cover each ration of bread with an inverted bake pan of the size of the baked loaf. This will retain the moisture and prevent heavy crusting. Small size of loaf recommended on account of the increased cost of the ingredients used, all "rations" of bread may then be sold at the same price.

75. **Parker House rolls.**—Straight dough for about 150 rolls. Flour 11½ pounds, water or milk 2 quarts, potato ferment 3 pints, lard 1½ pounds, sugar ¾ pounds (or, better, ½ pound of malt extract, standard, and ½ pound of sugar), salt 3 ounces. With the amount of ferment given, the dough will be ready in eight or nine hours. The same result would be obtained by the use of 2 ounces of compressed yeast and 3½ quarts of water. When sufficiently proved, take pieces of dough of convenient size and roll out until about ⅝ of an inch thick. Cut out with the top of a can or cutter, about 3½ inches in diameter, having first greased the top surface of the dough. Strike through the center of each piece with the edge of the hand; double over one half upon the other, and place in a bake pan, keeping them well separated and edges greased to prevent sticking together. After about doubling in size in the proof box, bake in a quick oven for about fifteen minutes. For quicker work the dough is rolled into cylindrical shape under the hands, as in molding a loaf, until it is about 1½ inches in diameter. Pieces are broken successively from the end of the roll in sizes suited to the roll desired, and these pieces of dough are quickly rolled into balls—one under each hand—by a rapid inward circular motion. The balls are then greased, struck in the middle with the edge of the hand and doubled over as before.

76. **Cinnamon buns.**—Straight dough for about 150 buns. 11½ pounds of flour, 2 quarts of water or milk, 3 pints of ferment (or 2 ounces of compressed yeast and 3½ quarts of water or milk), 2 pounds of sugar, 1 pound of lard, and 3 ounces of salt. Mix well and allow to prove for eight or nine hours. When ready, roll out into thin sheets about 8 inches wide and of convenient length, grease well

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(except about 1 inch of the inner edge, which should be wet with water to make the bun stick together when rolled). Sprinkle liberally with sugar and cinnamon. Begin with the outer edge and gradually roll firmly toward you until the roll is completed. Cut into lengths of about 1 inch (depending upon the thickness of the roll desired) and place them close together in the bake pan, greasing the edges to prevent sticking; or if there is plenty of room, separate them well in the pan, and instead of securing a tall bun you will get one that is flat, as in this case the bun will widen out in proving instead of pushing upward. Let prove for about one and one-half hours and bake in a quick oven.

77. **Tea buns.**—Prepare dough the same as for cinnamon buns. When the dough has proved sufficiently roll out into sheets about ½ of an inch thick, cut into disks about 3 inches in diameter. Place in bake pans, keeping the buns well separated; let prove for about one and one-half hours and bake in a quick oven.

78. **Crullers.**—Prepare in the same way as tea buns, except that when they have proved sufficiently they are fried in an iron pot containing several inches of smoking fat. When well browned they are removed, using a long pine stick (as a matter of convenience), and rolled in sugar.

79. **Doughnuts.**—Whip together for about five minutes 1 pound of sugar, 6 eggs, 2 ounces of salt, and 1 teaspoonful of lemon extract. Mix in 6 pounds of flour and 5 ounces of baking powder, adding enough water to make a soft dough. Drop the dough into the hot fat with a basting spoon; each time before using, dip it into the water to prevent the dough from sticking to it; repeat until the surface of the fat is covered, leaving only room for turning. Turn the doughnuts with a clean stick until evenly browned; remove with a skimmer and place in the dripping-pan. Sprinkle lightly with sugar. Repeat the operation until all the dough has been used up.

80. **Jelly rolls** (20-inch lengths).—Mix 1 pound of sugar, 2 ounces of lard or butter, 8 eggs (add a little flavor), ½ pint of milk, 1 ounce of baking powder, 18 ounces of family flour.

Bake in a sheet 20 inches long and 15 inches wide. After baking turn it upside down on a sheet of paper spread on a table. Spread jelly on the top surface and roll it up, leaving the paper on the table.

81. **Pie crust.**—Take 5 pounds of flour, 2½ pounds of lard, about 1 ounce of salt, and 1 quart of water. Mix the lard and salt with the

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dry flour. Add the water gradually and work just enough to hold together. Roll out about $\frac{1}{8}$ of an inch thick.

For 100 pies about 34 pounds of flour will be required. Have the tins well greased. When baking lemon, custard, or other pies without a top crust, bake the lower crust slightly before putting in the filling, providing cooked material is used.

NOTE.—A flour with little gluten and much starch (say, white winter wheat) is best for pies and pastries, the idea being to make pie crust that is crisp and crumbly in distinction to one that is tough. The latter result is obtained by using a strong glutenous flour.

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CHAPTER V.

POST BAKERY EQUIPMENT.

82. **Ovens—classification.**—Ovens are classified—

1. **As to the manner of firing,** into—

(*a*) *Continuous types*, in which the heat generally passes around the oven, rendering it possible to make successive bakings by the same continuous fire. In the "draw plate" ovens, however, heat is introduced directly into the oven chamber by means of the so-called "steam pipes." Among the former are the Simpkins, Clauss, Petersen, Duhrkop, etc., and the only "draw plate" oven now installed at army posts is the Werner and Pfleiderer.

(*b*) *Intermittent types*, in which it is necessary to draw the fire before each baking, if baking is done in the chamber in which the fire is built, as in the common brick oven and the semicylindrical type of the knockdown field oven; or in other types, to let the fire die down at some time while each successive batch is being baked, thus requiring a certain lapse of time between the bakings.

2. **As to their portability,** into—

(*a*) *Permanent ovens*, which are generally built of solid brick, with no intention of moving them, and weighing as much as 50 tons. Such ovens are installed at most post bakeries. They include the Simpkins, Clauss, Duhrkop, Petersen, Werner, and Pfleiderer "draw plate," the common brick oven, etc.

(*b*) *Portable ovens*, which can be taken down and moved. The term is applied to the Middleby, that can be taken down tile by tile and moved in many days, as well as to the light knockdown field ovens that may be taken down and prepared for wagon transportation, or set up in a few minutes.

INSTRUCTIONS FOR FIRING AND REPAIRING.

83. (1) **Brick ovens:**

1. *Firing.*—(*a*) First time. An oven that has never been fired should be heated by a *slow continuous fire* for four or five days, with

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all the dampers open to allow the moisture from the materials of which it is constructed to escape, then fire heavy enough for two days to attain a baking temperature. (If not required for immediate use it would be advisable to let the oven stand with all drafts open from two to four weeks before starting the first fire.)

(*b*) Cold oven: Brick ovens, if cold, take from two to four days to heat up before they will do good work, and even then the chances are that they will not have become equally heated throughout, baking top and bottom equally well.

(*c*) Daily: For the daily firing when the oven is regularly used, start the fire at least two hours before baking, leaving the draft dampers open. After the fire is well started put in about 2 bushels of coal, and after it is about half consumed, close the draft dampers and the ash-pit door. Be careful not to make too hot a fire at any time, but regulate the dampers according to the draft. Fire boxes have frequently been practically ruined in a few weeks by intense heat. Keep the fire "clean" at all times and do not allow the ashes to accumulate in the pit. Should the grate bars become embedded in ashes, they will warp and burn out.

All ovens possess certain peculiarities and new bakers can not expect to turn out loaves of uniformly good quality until they have become accustomed to the particular oven in use. In many double ovens, that part near the common partition becomes hotter than other parts—likewise the parts of the oven farthest from the door. Hence it is that pans of bread first run into the oven may go to the hottest parts, and from necessity may be the last to be withdrawn. If such an oven is used to its fullest capacity, some of the loaves are apt to be highly browned or even burned before others are ready to be withdrawn, as shifting under these circumstances is done with difficulty. Care must be taken to keep pans away from the common partition of such an oven and to fill the cooler parts first.

2. *Dampers.*—While preparing the oven for firing the oven damper should be kept closed. In case the oven becomes too hot the temperature may be reduced by opening this damper and also the oven door to give circulation through the oven. When running bread into the oven this damper should be opened to draw off the dust that is raised and the moisture from the loaves. It should be left open for the next ten minutes or such a matter, cooling the oven and giving the bread a better chance to spring up from the bottom before the framework is fixed.

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Brick ovens with hot-water connection also have another damper to be used in connection therewith and it should be regulated according to circumstances.

After each day's firing all dampers should be kept closed to retain all the heat possible within the oven.

3. *Firing from the rear.*—Most ovens are fired from the baking room, causing unnecessary littering up and annoyance. Wheelbarrows of coal, or piles of wood, may be in the way, and present an untidy appearance. On cold mornings, when first firing ovens, gas and smoke may escape into the baking room, blackening the walls, and rendering work at such times most disagreeable. In the larger bakeries the ovens should be fired from the rear—from a room entirely detached from the baking room—unless oil or gas is used for fuel. It can generally be arranged to have the firing done from the boiler room, without extra assistants, where other fires are necessary for heating the bakery, supplying hot water, and running machinery.

4. *Tiles.*—Furnace tiles should last about three years. They should be installed by a mechanic familiar with such work.

Water must *not* be thrown in the oven to cool it. If this is done the tiles will crack.

5. *Grates.*—If care is taken in keeping the fire clean and not allowing ashes to accumulate in the ash pit, the grates will last about three years. Any mechanic can replace damaged grates.

If the casing which contains the sockets for the grates is burned out, a mechanic familiar with such work should be employed to install the new casing.

6. *Repairs.*—All repairs, especially brickwork, should be made by a mechanic familiar with brickwork in oven construction.

7. *Mopping out the oven chamber.*—It is necessary, from time to time, to mop out the oven chamber to remove dust, etc. Water must not be thrown in the oven for this purpose, as this will cause the tiles to crack.

To mop out an oven, tie a gunny sack on a long pole, dampen the sack (not soak in water), and mop out the oven chamber with the damp sack.

8. *Cleaning the flues.*—About once in ten days a quick wood fire should be made in order to burn out the flues and maintain a good draft. "Clean-out" doors are provided for removing such ashes

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as accumulate and can not otherwise be removed. Generally it will not be necessary to use them oftener than once in six months or a year.

(2) **Marshall continuous baking oven.**—This oven is constructed by the Middleby Oven Company, of Chicago, Ill. The oven with outside measurements 10 by 12 feet is designated as No. 30, and the 12 by 14 feet as No. 40.

1. *Firing.*—The same general rules for firing as given for brick ovens should be observed, though it does not require so long to prepare for the first baking.

2. *Tiles.*—The tiles are said to be practically indestructible, except those of the arch directly over the furnace. These are interchangeable, and should one be required for repairs it can be replaced by a mechanic unacquainted with the oven.

3. *Grates.*—In ordering, give designation of oven.

4. *Cleaning.*—The only flue of the oven that will ever require cleaning out is the top or roof flue, and this is easy of access. It should be cleaned out with a brush every six months to a year, depending upon the kind of fuel used.

(3) **Middleby ovens:**

1. *Firing.*—(*a*) First time. An oven that has never been fired should be heated with a *slow continuous fire* for about forty-eight hours, with dampers open to allow the moisture from the materials of which it is constructed to escape. Baking is more uniform after several days use.

(*b*) Daily. In firing, build fire with damper and lower ash-pit door open. As soon as fire is well started, put in as nearly as possible all the fuel that is needed for heating the oven. If using coal or coke, from 1 to 2 bushels should be sufficient for a single batch; if using wood, about one-sixth of a cord for a single batch or one-half cord for five consecutive firings and bakings in ten hours. When the fuel is burning properly, close the damper in the pipe one-half to two-thirds, according to the strength of the draft. Allow the oven to heat in this manner for about one hour and a half, then close the damper in the pipe and lower ash-pit door, the oven to remain closed in this way for about an hour and a half, in order that the heat may become "solid" or even. In consecutive bakings, after the first, allow one hour for firing and equalizing temperature.

Care must be taken that the damper is closed before the fire is so

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low that more heat escapes up the chimney than is received from the furnace.

Never in any event build or allow a fire to remain inside of the lower two doors in the ash pit.

2. *Tiles.*—In ordering tiles state whether they are required for the hearth, walls, roof, or furnace of oven. If for the roof, state whether they are approximately 19 or 23 inches long. *If tiles for the furnace are required, give description and rough sketch showing shape of tiles.*

3. *Grates.*—In regard to grates, styles Nos. 1 and 2 purchased prior to March, 1905, and No. 3 purchased to February, 1904, are equipped with round grates, and the order should call for round grates. No sketch is needed. Style No. 4, purchased prior to February, 1904, is equipped with shaking grates or bars. Since November, 1905, all ovens are equipped with a standard grate.

In requesting any grate except the round grate, send a rough sketch.

4. *Material for plastering.*—Slake one bushel of lime, mix into mortar with sand, and work into this mortar about 15 pounds of loose asbestos cement. This will furnish enough for the largest Middleby oven. Sufficient asbestos paper will be sent for use with the asbestos cement.

5. *Plastering.*—Plaster the joints, bottom of the oven, along the sides, corners, and ends, as may be required. When this is done, cover the whole of the top of the oven with asbestos paper, each strip lapping over the next about 5 inches, so that there will be no chance for the sand to leak through into the oven. Care must be taken in putting the asbestos paper over the beams; that is, not to draw it so tightly that the weight of the sand will tear it.

6. *Repairs.*—If not sure how to make the repairs, instructions should be requested from the chief commissary of the department.

84. *Dough mixer.*—Each day after using, scrape clean and grease thoroughly with about 1 pound of lard or compound.

All bearings should be oiled three times a week.

85. **Dough troughs.**—Dough troughs were formerly made of wood, and of such kind (generally poplar) that an objectionable flavor would not be taken up by the dough. A wooden trough has the advantage of being a poor conductor, and therefore keeps the dough at a more constant temperature than a steel trough would in the field or small bakeries subject to sudden changes. These troughs have,

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in the larger bakeries, been replaced by steel troughs, which are easier to keep clean. The latter are mounted on rollers for more convenient use in connection with the dough mixer and for running in and out of the proving room.

Sourness in bread is frequently caused by particles of dough becoming lodged in the cracks of wooden troughs, souring and setting up acid fermentations in dough that is afterwards set in the trough. Wooden troughs must be frequently washed with hot water and lye, thoroughly rinsed and dried—preferably in the sun. Steel troughs are so constructed that they are readily cleaned with a scraper and brush, and there are no cracks in which the dough can lodge and become sour. (See pars. 23 and 70.) Steel dough troughs are generally kept in the baking or mixing room with a temperature of 80° F. or more, and consequently can not as a rule be of a much lower temperature than the dough or sponge. It does not therefore necessarily reduce the temperature of the dough, as is sometimes stated, but is simply cold to the touch for the reason that it is a good conductor.

86. **Molding table.**—Molding tables should be constructed of the same material as wooden troughs. For large bakeries, where many bakers are employed, the table should be broad and set out in the room so that the bakers may work on both sides of it. Where there are but few bakers, the table should be smaller and built with a flange, as indicated in illustration. The flange is for the purpose of preventing the dough from spreading and falling to the floor.

87. **Proof room and proof box.**—In the larger bakeries proof rooms are generally provided, and the bread as soon as molded is rolled into the room on specially constructed "proof racks." The room is generally heated with free steam and kept at a temperature of about 80° F. The proof room is also a great convenience for proving the sponge and dough; the sponge is set, or the dough kneaded, in a convenient place at a moderate temperature and the trough, mounted on rollers, is run into the proof room, where the dough will prove most satisfactorily under the fixed and favorable conditions provided. Especially is the proof room appreciated in cold and uncertain weather, when it is difficult or impossible to keep the temperature of the baking room at the same even temperature. (See par. 58.)

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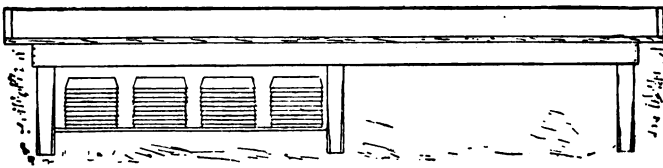
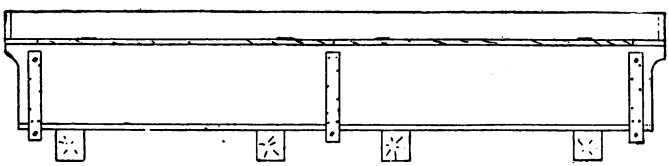
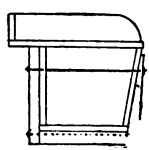


MOLDING TABLE.

Material.—Preferably poplar.
Capacity.—About 500 rations.
Dimensions.—Length 15 feet, width 4 feet, height 2 feet 10 inches. Flange 8 inches high.
The top and flange are of 2-inch lumber, thoroughly seasoned; the supporting frame, strong and firm.
Pans when not in use are telescoped and placed bottom side up on subshelf—this prevents dust from settling on the inside of pans.





Material.—Preferably poplar.
Capacity.—About 500 rations.
Inside dimensions.—Length 14 feet 6 inches, width at top 26 inches, at bottom 22 inches, top flange 8 inches high. Inside raised 10 inches above the floor by means of supports. The trough proper is constructed of 2-inch lumber. The top is provided with two lids of 1-inch lumber, each covering one-half of the trough and provided with strong hinges. Two dam boards are provided to fit the trough—they are of 2-inch poplar.

At the smaller posts proof rooms are not generally provided, and proof boxes are supplied instead. A proof box consists essentially

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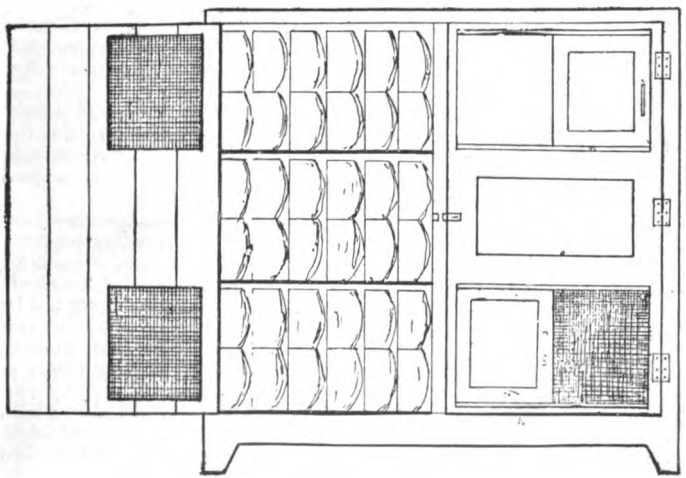
of a box or cupboard that is practically air-tight; several shelves of slats are provided for supporting the pans and permitting free circulation of such heat and steam as may be generated for heating the box. (See par. 65.)

88. **Bread room and bread box.**—In the larger bakeries bread rooms are generally provided and the bread may, for convenience,



BREAD BOX.

Inside dimensions.—80 inches high, 90 inches wide, 36 inches deep, about 25 inches between shelves.

Box divided into two equal compartments by a solid partition through the middle. On each side of box sufficient space is left in front and rear of shelves to allow an upward draft of air.

Capacity.—About 1,000 rations.

be placed on the steel racks as soon as it comes from the oven and be wheeled into the bread room, where it remains undisturbed until issued. If a bread room is not provided, the bread must be cared for in bread boxes or closets, as explained in paragraph 65.

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89. **Fixtures.**—Wooden shelving, cupboards, bread boxes, etc., are great cockroach and vermin gatherers and so far as possible should be done away with.

It is recommended that sinks be set out from the wall, that pan racks be made of metal and set on wheels, and that when practicable a *bread room* be provided so that the bread may be issued from the racks upon which it is placed when drawn from the oven.

90. **Number of bakers required.**—One baker should be able to handle 250 rations of bread, two bakers 700 rations, three bakers 1,000 rations, providing they are not required to attend to any other duty. In addition, there should be an apprentice.

91. **Daily routine, etc.**—The post bakery should be scrupulously neat. On account of the nature of their work, bakers must bathe daily, making a complete change of underclothing. They should be provided with 12 aprons and 4 caps each, furnished and laundered at the expense of the bakery fund.

The necessity for clean utensils and equipment is appreciated by every up-to-date baker and is fully explained in preceding pages.

Each morning, after the molding is done, advantage should be taken of the period of proving—about one and one-half hours—to clean up the bakery and equipment, as there generally would not be any further littering up for the day. The mixing machine and dough troughs should then be thoroughly cleaned and greased. Each time a bread rack is emptied it should be brushed clean or washed when necessary.

Once a week wooden dough troughs should be scrubbed out with lye and hot water and then sunned for an hour or two. Molding tables and floors should be brushed or swept clean daily and scrubbed twice a week.

The chief baker should be held responsible for the police of the grounds in the immediate vicinity of the bakery.

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CHAPTER VI.

FIELD BAKING AND FIELD BAKERY EQUIPMENT.

92. **Equipment.**—The proper equipment for field bakeries, as determined by experiment and practical experience, is announced from time to time in circulars from the office of the Commissary-General. It is based upon the requirements of a regiment of infantry, with a view to combining two or more regimental bakery equipments to form a bakery for a brigade or division. Detached battalions should draw bread from the nearest bakery.

The authorized equipment for a regimental field bakery is given in the Subsistence Manual.

A field bakery should be established and operated in connection with every post bakery in order that bakers may become thoroughly familiar with the field equipment and confident of success when required to use the same.

93. **System used.**—The straight dough system should be used in the field as a saving of time and labor. If using the intermittent type of oven, the doughs should be set so as to follow each other at a period of about two hours and a half if baking double rations, and two hours if baking single rations.

This will allow three-fourths of an hour for firing and one-half hour for equalizing temperature. This has been found to be sufficient for each firing after the first, for which one hour and a half should be allowed. While using this equipment from three to four runs of bread will have to be made daily.

94. **Straight fire knockdown field oven.**—In this kind of an oven a jacket of earth forms an essential part, and the baking properties depends largely upon the heat absorbing and radiating capacity of the materials used. If the soil is sandy, the jacket of earth may be dried out in a few hours and good results obtained, but if the soil is of clay and permeated with moisture, it will take much longer to get satisfactory results; especially is it difficult to get a good browning on the bottom of the loaves until the oven has been used for

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several days. Wet clay can not take up and radiate heat of a sufficiently high temperature for baking. This temperature should not be below 385° F.

The ovens here referred to are called "straight fire" or "draw fire" for the reason that the fire is built in the oven chamber, and is drawn when the oven has been sufficiently heated for baking. The amount of fuel to be used can be so regulated by experience that there will be few coals remaining to be withdrawn when the oven is ready for use. The fire being withdrawn, the oven should be closed up tightly for an hour or more to equalize the temperature throughout. The oven is then ready to receive the loaves, and care should be exercised to have it in readiness when they are sufficiently proved.

Great care should be exercised in firing these ovens. *Intense heat must be avoided,* as it will ruin an oven in a few weeks. A slow fire for an hour to an hour and a half produces best results, and an oven so fired has been used almost continuously for fifteen months, while others heavily fired have been ruined in one month.

As a substitute for a proof box, the mixing tent will have to be maintained at about 80° F., and a suitable proof rack constructed from materials at hand.

95. **Size of loaf to bake in field oven.**—There are certain dimensions that go to make up a well proportioned loaf. For instance, a single ration loaf about 12 inches long should be about 3 inches wide and from 3½ to 4 inches high, while a 2-ration loaf of the same length should be about 4 inches wide and from 5 to 6 inches high, the height of the loaves depending upon the proof that is given them and the temperature of baking.

It takes a certain amount of heat, about 385° F., to bake one ration of bread, and under the same conditions it would take about twice as *much* heat to bake two rations or a 2-ration loaf. Suppose that the capacity of the oven is *84 single rations* of the dimensions given and that the heat developed is just about sufficient to bake them. It is at once apparent that there may not be enough heat to bake the full number of double rations that may be placed in the oven. In the first instance we may consider that sufficient heat has to be stored up to bake a sheet of dough about 3½ inches deep, and in the second a sheet of dough about 6 inches deep, and the number of heat units and the time required will be about in the same propor-

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tion. From experience we find that a 2-ration loaf taken from the oven at the time a single ration is baked will be underdone—a portion through the center being a mass of dough. If such loaves are returned to the oven and are left in a temperature much less than about 350°, they will be subjected to a drying-out process rather than to a baking heat, and the resulting loaf will have a thick, dry crust and a soggy interior. Hence, we see that in this particular case it would have been *safer to have baked single rations than double ones.* It is evident that the only way in which the heat of the oven can be increased is by refiring.

On the other hand, *if the oven is too hot* and not carefully managed, a 2-ration loaf is apt to be burned on both the top and bottom while a single-ration loaf might be baked without burning, being subjected to this intense heat for only about half as long a time.

Single rations of the dimensions given should be baked in from twenty-five to fifty minutes and *double rations* in from fifty minutes to one hour and twenty minutes.

It is evident that *if single rations be crowded* in a pan we soon approach the difficulties met with in baking a double ration and at the same time we get a loaf of awkward and irregular outlines. On the other hand, *if 2-ration loaves are allowed to spread out* until they have about the same thickness as single rations, they can be baked with the same facility.

In any case *great care must be exercised while baking in a straight fire field oven*, as the amount of heat is variable and not easily judged; therefore the door should be left slightly ajar from the time the loaves are placed in the oven until they are browned, and looked at frequently to see that they are not burning. They should be brown in about fifteen minutes and then the door may be closed, and the baking proceed with less attention. One shifting at least will generally be necessary, and care should be exercised not to jar the pans at this time, for the framework of the loaf is not yet formed throughout and if the crumb falls away from the crust it will not be restored and the bread will be heavy.

It is recommended that single rations be baked until great facility is required in handling the oven.

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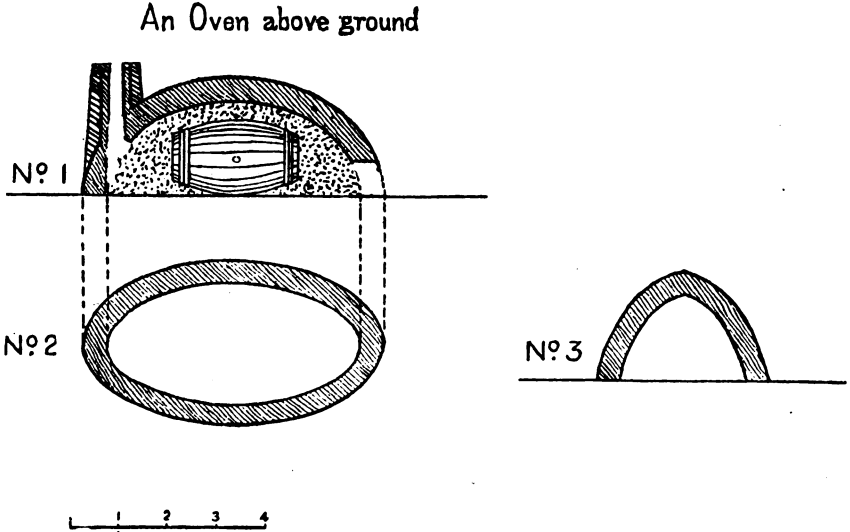

EXTEMPORIZED OVEN BUILT ON LEVEL GROUND.

No. 1.—Longitudinal section, showing method of construction. No. 2.—Plan. No. 3.—Transverse section at centre of dome.

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To build such an oven a rounded heap of dry earth or sand, about 5 feet long, 2 feet 6 inches wide, and 1 foot 9 inches high, should be raised. This is the mold on which the oven is to be formed. Sand is more suitable for the mold than earth, it being more readily removed. Willow twigs bent over and closely wattled together, or a flour barrel laid flat and covered completely with earth, will likewise suffice to give form to the mold. Mix a stiff mud or mortar, and plaster the mold over 5 or 6 inches thick, commencing at the base. Allow one or two days for it to dry and harden, plastering up all cracks which may appear. When nearly dry, cut out the door at one end and the flue at the top of the other end. A small mud chimney raised over the flue will greatly improve the draft. Carefully withdraw the loose earth or sand from the interior. If a barrel has been used for the mold it may be burned out without damaging the oven. Keep a small fire in the oven for at least half a day before attempting to bake. Dig a pit in front of the oven for the convenience of the baker.

Two men can build this oven in three hours, but it will generally not be fit for use for two days. It will last several weeks, and prove very satisfactory.

This oven may also be built dome-shaped, like the household ovens used by the Mexicans. This kind of an arch would be stronger than the semicylindrical form, but with the same quality of material used would not have as great a baking capacity.

The clay oven is peculiarly adapted for use when camping on swampy ground. Under such circumstances it may be constructed upon a platform of stones or logs covered with clay.

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CHAPTER VII.

FIELD-BAKING EXPEDIENTS.

96. **Essential principles.**—Occasions are sure to arise when it is desirable to bake bread in the field when no proper baking equipment or no equipment at all is provided. Under these circumstances the essential principles to be followed in the construction of earth or clay ovens must be thoroughly understood, as well as the methods to be followed in preparing and preserving yeasts and proving the sponge and dough.

97. **Ovens.**—The entire principle of baking is based upon the fact that for each ration of bread baked a certain number of heat units must be provided at a temperature from about 385° F. to 450° F., striking the top and bottom of the loaf with about the same intensity. The *quantity* of the heat available must be such that a baking temperature will be maintained from thirty minutes to an hour and a half, depending upon the depth of the dough to be baked.

Such ovens as are generally constructed in the field must generally be of the simplest type possible—that is, of a single chamber in which the fire is built and withdrawn after sufficient heat has been stored up in the surrounding material to do the necessary baking. Such ovens are generally called "straight-fire" or "draw-fire" ovens, and for temporary use are very satisfactory, though they are more laborious to handle than continuous ovens. In the construction of these ovens the following points should be kept in mind:

1. *The oven must be built of material suitable for absorbing and radiating* the heat required in baking. Brick, rock, adobe, clay, sods, sand, and loamy soil will all do if properly handled.

2. *About 8 inches of earth* of any kind is required to take up and radiate sufficient heat for baking even small batches of bread. A greater depth on top of an oven will cause premature breaking—a lesser amount would not generally retain sufficient heat.

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3. *A slow fire must be placed in the oven* in order that the heat may gradually be taken up in the surrounding material. A flash heat will quickly heat up the inner lining of the oven and produce an intense heat for a short time, but to store up a sufficient *amount* of heat requires a long, slow firing.

4. *The greatest difficulty is in getting a bake on the bottom of the loaves* in newly constructed ovens, as the heat from the fire rises from the bottom, which is further protected by the ashes as they accumulate. Especially in damp and loamy soils should a hearth of stone or brick be provided to overcome this difficulty.

5. *Soil while damp* can not take up and radiate sufficient heat between 385° and 480° F. to bake bread. Hence the material immediately surrounding an oven must be thoroughly dried out before any attempt is made to bake. Generally a "slow" fire for several hours will be necessary before the first baking can be made, but after a successful baking not more than three-fourths of an hour to an hour will be required for heating the oven and equalizing the temperature by tightly closing up the oven after the fire is drawn.

6. *The temperature is best determined by inserting the arm well back into the oven chamber* and holding it there as long as possible, counting seconds. For a new oven about 12 counts (second counts) will be about right, as a little moisture is still present, or the surrounding material is not dried to as great a depth as in later bakings, and hence the first heat should be a little stronger. Later on 15 or 16 counts will be the right number.

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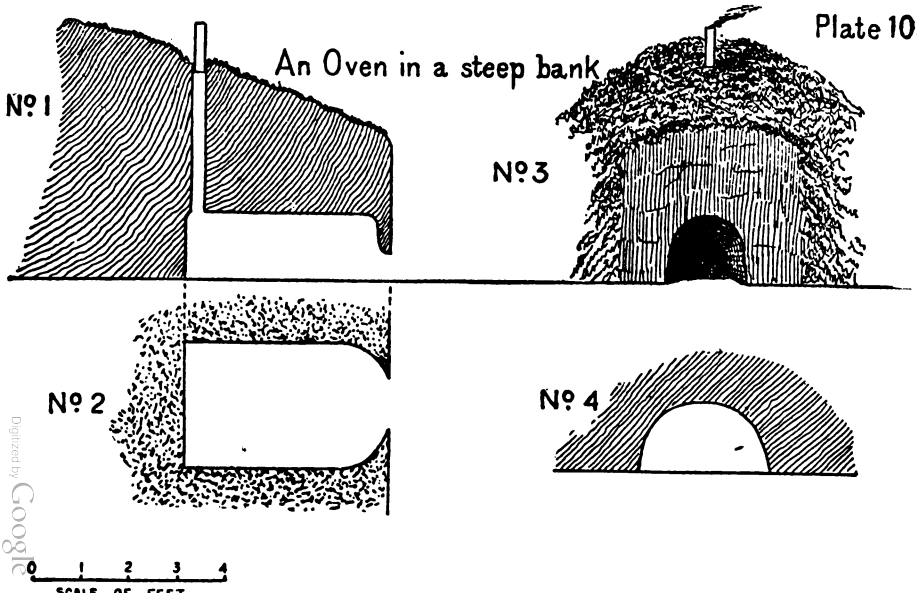
Plate 10.



EXTEMPORIZED OVEN BUILT IN A BANK.

No. 1.—Longitudinal section. No. 2—Plan. No. 3.—Front view; not on the scale. No. 4.—Transverse section of interior.

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This is recommended as a very good and convenient oven. A bank from 4 to 6 feet high is the best for the purpose. The roof covering need not exceed 1½ feet. Two men with a spade and a long-handled shovel can build it, in light soil, in three-quarters of an hour. If such tools are not available, it may be constructed with trowel, bayonet, intrenching tools, or even with knives. To build the oven, dig down the bank to a vertical face and excavate at the base a hole from 4 to 5 feet horizontally, care being taken to keep the entrance as small as possible; hollow out the sides of the excavation and arch the roof until the floor is about 2 feet 6 inches in its widest part and the roof 16 inches high in the center of the arch. Then tap the back end for the flue. A hole from 4 to 6 inches in diameter will furnish a good draft. A piece of tent stove pipe may be utilized for this purpose. When difficult of construction, the flue may be omitted, and practically as good results will be obtained. The time required for drying will depend upon the character of the soil; if ordinarily dry, a fire kept up for an hour will suffice.

After the oven has been heated the temperature may be regulated by means of the door and flue—opening or closing them as may be necessary.

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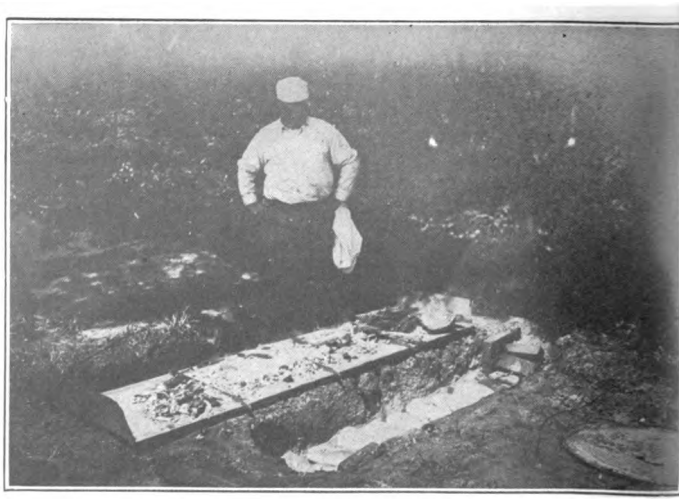

BAKING IN THE OPEN TRENCH.

A trench is dug about 6 feet long and 15 inches wide and about 1 foot deep. A fire is built in the trench about two hours before the time to bake. A few minutes before the loaves are ready the coals are withdrawn and the trench swept clean. The loaves (Vienna-shaped and very dry on the exterior) are carefully laid in the trench about 1 inch apart, covered with an iron sheet of any kind, and the coals, which were drawn from the trench, distributed over the top. By carefully watching the bread and regulating the top heat most excellent bread can be produced, and in an oven of the dimensions given 25 rations (single) can be baked.

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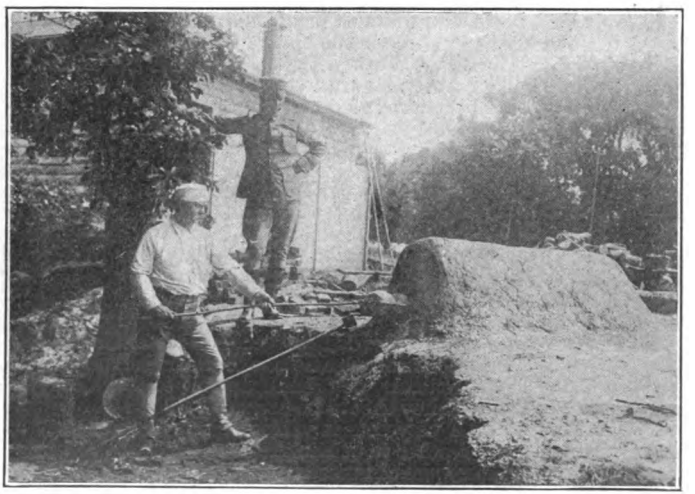

DOUBLE-BARREL OVEN.

Made by placing two sugar barrels end-on and covering with about 2 inches of wet sand and 4 inches of common clay mixed with straw or hay. The oven is let stand a couple of days and then dried out by a slow fire. Thereafter it is used, as explained, for straight-fire knockdown oven and with equally good or better results. Capacity, 80 rations.

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98. **Proving the sponge and dough.**—In order that the sponge and dough may prove satisfactorily there must be a uniform temperature of about 80° F., and the same may be said of the loaves while proving in the pan. Small sponges and doughs may be proved in a *fireless cooker*, if they are of the proper temperature when put in. Following the same idea a *small pit* may be dug in the ground and heated with hot bricks that are withdrawn before the receptacle containing the dough is introduced. After the sponge or dough is put in the pit provided, it should be covered tightly to retain the heat and keep it warm. Remember that while the sponge or dough is proving a certain amount of heat is being generated as a result of fermentation (working of the yeast) and this will generally offset the loss when the fireless-cooker or pit method is used. More satisfactory still would be *a small cave or closet* covered with earth, large enough to put in shelving for the pans of loaves. The cave or closet should be heated with bricks or hot water and the door should be as small as practicable. In mild weather *a box with shelves*, or a *rack closely covered with canvas* and heated as above indicated will prove satisfactory. *Greased paper* spread over the loaves in a pan will do much to retain the heat generated, but alone this will not be sufficient in cold weather.

99. **Preparation and preservation of yeasts.**—Materials for the preparation of yeasts according to some one of the formulas given in Paragraphs 35–37 will generally be at hand, and if yeasts are not procurable on the market, they should be prepared.

For the preservation of yeasts it will generally be sufficient in either warm or cold weather to utilize the *fireless-cooker* or *pit* idea, being careful to get a proper temperature for the receptacle and then to maintain it by nonconductors. To preserve yeast in hot weather, a pit should be dug in moist soil or in a constantly shady spot and the receptacle for the yeast should be surrounded with damp gunnysacks.

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